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ABSTRACT

This Vocational-Technical Education Consortium of States (V-TECS) catalog contains the state-of-the-art tasks and standards of performance for the occupation of laser system technician. It provides the curriculum specialist or instructor with the foundation for instructional development. Performance objectives and performance guides are provided for 11 duties: maintaining records, installing laser systems, maintaining laser systems, analyzing down laser systems, repairing temperature control system, repairing beam generation system, repairing excitation system, repairing low voltage power supply, repairing RF system, repairing vacuum systems, and repairing gas supply system. The duties are comprised of 89 performance objectives. Each performance objective is composed of a task, standard, and conditions for performance of task. The performance guide for each performance objective is a list of all of the steps required to perform the task on the job successfully. A source for the standard is also identified. Appendixes include a list of standard tool kit contents; tools/equipment/work aids by percentage of laser systems technicians using them; bibliography: sources of standards; cross-reference table; and state-of-the-art bibliography. (YLB)

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A CATALOG OF PERFORMANCE OBJECTIVES AND PERFORMANCE GUIDES FOR

LASER SYSTEM TECHNICIAN

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LASER SYSTEM TECHNICIAN

A Catalog
of Performance Objectives
and Performance Guides

State of Florida
Department of Education
Ralph D. Turlington, Commissioner of Education
Tallahassee, Florida
Affirmative action/equal opportunity employer

Division of Vocational, Adult, and Community Education

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LASER SYSTEM TECHNICIAN

A Catalog
of Performance Objectives
and Performance Guides

Developed by
PENNSYLVANIA V-TECS

Edited by
Florida V-TECS
Florida Department of Education

Cover Design by
Center for Studies in Vocational Education
Florida State University

RALPH D. TURLINGTON
COMMISSIONER

STATE OF FLORIDA
DEPARTMENT OF EDUCATION

TALLAHASSEE 32301

Dear Florida Vocational Educator:

There is no greater need in education today than to insure that learners are prepared to assume their roles as responsible, competent citizens when they leave formal education. Competency-based education makes a direct link between those things which learners must master while in school, and the skills and knowledge that they will need in the real world.

The Division of Vocational Education has made a commitment to establish competency-based programs around the state. A major step towards this goal is the dissemination and diffusion of the Florida V-TECS catalogs of performance objectives in selected occupational areas.

The establishment of competency-based vocational education programs, of which the Florida V-TECS catalogs are a crucial part, will make it possible for learners, parents, teachers, administrators, legislators, and the general public to have increased confidence that our educational system is preparing people for useful, successful lives.

Sincerely,

Ralph D. Turlington

reb

Affirmative action/equal opportunity employer

RALPH D. TURLINGTON
COMMISSIONER

STATE OF FLORIDA
DEPARTMENT OF EDUCATION

TALLAHASSEE 32301

Joe D. Mills
Director
Division of Vocational Education

Dear Florida Vocational Educator:

We in vocational education know that Florida's manpower needs are changing. We have seen new technology make some occupations obsolete, completely change others, and create still others. To meet these changes, vocational education has expanded at an amazing rate in the past 10 years. Even with this growth and the efforts of many fine vocational educators, we still have to find new ways to meet the demands of change.

We are convinced that competency-based vocational education is one key to the future. Competency-based vocational education will meet real economic needs in that it will require each learner to master only those objectives needed for entry into his/her chosen occupation.

The first step in establishing a competency-based course or program is the development of a set of performance objectives which describes what a learner must be able to do. The Florida V-TECS catalogs provide help in defining that first step. These catalogs are the most accurate, up-to-date descriptions obtainable of the skills an individual needs to perform adequately on the job. The tasks and objectives included in this catalog were agreed upon by teachers and workers in the field as the ones necessary for success in a job. All tasks have been validated to insure their applicability to this occupational area in Florida.

It is going to take a great deal of time, talent, and effort to establish competency-based vocational education programs throughout the state. Much of that effort will have to come from vocational educators at the local level. The fact that in the past many vocational educators in Florida have already been striving for student competency in skills convinces me that this approach is sound and will be widely accepted by the profession.

I plan to continue supporting the excellent efforts made by Florida vocational teachers to establish a modern, competency-based system of vocational education that meets the challenge of the future. I believe that the Florida V-TECS catalogs will be a valuable aid in those first strides toward implementation of competency-based vocational education programs.

Sincerely,

Joe D. Mills

whb

Affirmative action/equal opportunity employer

DEFINITION OF TERMS

A number of terms frequently used in this catalog may be unfamiliar to the reader; others may be familiar, but in the context of this catalog have been assigned special meanings. To assist the catalog user, the following definitions are provided.

1. Domain. A group of related jobs within an occupational area.

2. Duty. One of the distinct, major work activities in an occupational area. A duty is made of numerous tasks.

3. Task. A unit of work with a beginning and an ending which is measurable and observable.

4. Occupational inventory. An instrument used to obtain responses from workers on what duties and tasks are actually performed in an occupational area.

5. Peformance guide. A step-by-step description of how a task is ordinarily performed on the job.

6. Competency. The ability (including knowledge, skills, and/or attitudes) to perform a specific task or duty successfully.

7. Competency-based vocational education. A methodology of instruction that (a) identifies the competencies needed for on-the-job performance; (b) informs students and teachers of the precise and detailed learning objectives required to achieve these competencies; (c) emphasizes high performance standards in testing, course requirements, and/or graduation; and (d) individualizes learning by letting each student work at his/her own speed and master each learning task before going on to another.

8. Performance objectives. A statement of what the learner must do, in observable and measurable terms.

   a. Conditions: "Given what?".
   Describes the situation, including tools and equipment to be used, and limits under which the tasks will be performed.

   b. Task: "Does what?".
   States the observable activity the learner will perform.

   c. Standard: "How well?".
   Indicates performance required of a successful incumbent worker in an actual job environment.

9. D.O.T. code. A Dictionary of Occupational Titles nine-digit number developed by the U.S. Department of Labor that identifies a specific occupation. D.O.T. numbers for related occupations appear on the back of each V-TECS catalog.

10. U.S.O.E. code. A six-digit number used by the U.S. Office of Education to identify a specific occupational domain. These U.S.O.E. numbers appear on the back of each V-TECS catalog.

11. C.I.P. code. A six-digit number used to classify and identify instructional programs for selecting titles and identifying the scope and validity of data gathered for vocational instructional programs

What is V-TECS?

The Vocational-Technical Education Consortium of States (V-TECS), is a voluntary organization of fifteen states and four branches of the armed forces working to develop catalogs of performance objectives and performance guides for use with students in vocational-technical education. Each member is charged with developing catalogs for specific occupational areas that are then made available to the other member states. Coordination of V-TECS is provided by the Commission on Occupational Education Institutions of the Southern Association of Colleges and Schools (SACS). V-TECS members include Alabama, Arizona, Florida, Georgia, Illinois, Indiana, Kentucky, Maryland, Mississippi, Missouri, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia, the United States Air Force, the United States Army, the United States Navy, and the United States Marines.

What Does a V-TECS Catalog Contain?

A V-TECS catalog contains a group of tasks with performance objectives and performance guides appearing within several duty areas. The tasks are performed by workers in a specific occupational area. The occupational area covered in a catalog may include tasks applicable to several closely related jobs.

The performance objectives are comprised of three parts: conditions, tasks, and standards. The performance guide is a list of all the steps required to perform the task on the job successfully.

Each V-TECS catalog also contains a list of tools and equipment used by workers in the field and a list of references used in developing the catalog.

Development of V-TECS Catalogs

Each catalog is produced using the development model of V-TECS described below. Each catalog is produced by a catalog development team consisting of a project director, a state technical coordinator, incumbent workers, instructors, and administrators.

The development process includes the following steps:

1. Needs Assessment Conducted
   Every member state of the consortium selects occupations for catalog development. These occupations are identified through a needs assessment that represents the collective judgement of teachers, administrators, and state program directors. The Board of Directors of V-TECS assigns catalogs to states based upon their expressed preference. Following the assignment, each state technical coordinator selects a project director to develop the catalog.

2. Domain Report Prepared
   The first step in the development process is a review of the literature related to the occupation. This includes the collection of task analyses, competency-based curriculum materials, and pertinent documents and studies. Using these materials as a base, the project director conducts extensive surveying and interviewing of the incumbent workers in the occupational area to verify and add tasks performed in the occupation. These tasks are grouped under common areas called duties. In addition to the duty/task listings, the tools and equipment used in completing the tasks are identified. A further aspect of the domain report is the statewide identification of the population of workers in the occupaton. This report later serves as the basis for the random sample selection of the worker survey.

3. Workers Surveyed
   A survey of incumbent workers is conducted using the occupational inventory developed in the domain report. This sample is randomly selected from the total worker population in the state. Each respondent indicates whether a specific task is performed and may include related questions about employment practices.

4. Data Analyzed
   The data generated by the survey are computer analyzed to determine the percent of workers performing the task. These data serve as the basis for writing performance objectives.

5. Writing Team Organized
   A team of incumbents, teachers, and administrators cooperate with the project director and coordinator of projects to write performance objectives and performance guides. The result of this effort is compiled in a field review draft of of the catalog.

6. Field Review Catalog Developed
The field review catalog, containing the performance objectives and performance guides developed by the writing team, is reviewed by incumbent workers of the particular occupation. Each of the objectives is reviewed for its completeness and clarity of purpose. This edition is also approved by the central office of the consortium in Atlanta for technical accuracy and suitability.

7. Final Catalog Prepared
Comments from the reviewers are considered in the preparation of the final catalog for the occupation. This catalog is distributed to member states of the consortium.

Using a V-TECS Catalog

Each V-TECS catalog contains the state-of-the-art tasks and standards of performance for an occupation and it provides the curriculum specialist or instructor with the foundation for instructional development. Since a V-TECS catalog is not a curriculum, or a curriculum guide, a catalog should be used as a resource in the development of curricula and instructional materials. The user must identify enabling skills and develop cognitive information needed to teach the performance objectives in the catalog as the performance guide for each objective specifies only the psycho-motor activities for the performance of the task.

For a better understanding of how to use a V-TECS catalog, request a copy of Developing Vocational Education Programs from V-TECS Catalogs (Copyright 1983, Florida Department of Education) from the Division of Vocational, Adult, and Community Education, Bureau of Program Improvement, Research Coordinating Unit, Knott Building, 5401, Tallahassee, Florida 32301 or call (904) 488-0405 or Suncom 278-0405.

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Whenever a project of this magnitude is approached, the cooperation of a large number of dedicated and talented people with a variety of expertise is required to complete the task successfully. Associated Educational Consultants, Inc., feels that this was accomplished in producing this high technology catalog entitled, Catalog of Performance Objectives and Performance Guides for Laser Systems Technician.

Among the many people to be thanked are the members of the writing team: Mr. Edward Chara, formerly with Lasermation of Philadelphia, Pennsylvania and now with Laser Systems of Baltimore, Maryland; Mr. Ross Macklin of Aero-Tech, Pittsburgh, Pennsylvania; and Mr. Thomas Schaeffler of Quantronix, Smithtown, New York.

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And last, but certainly not least, Associated Educational Consultants, expresses its sincere appreciation to the members of the staff in the Bureau of Vocational Education in the Pennsylvania Department of Education especially Mr. Vernon Register who served as V-TECS Technical Coordinator for this project.

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PERFORMANCE OBJECTIVES

AND

PERFORMANCE GUIDES

DUTY: MAINTAINING RECORDS

PERFORMANCE OBJECTIVE NO. 1

TASK: Maintain laboratory notebook

STANDARD: Laboratory notebook must contain all information from experiments, recent tests, repairs, and/or operational notes. Information logged must be dated and initialed when entered into laboratory notebook.

CONDITIONS FOR PERFORMANCE OF TASK:

Laboratory notebook
Notes from tests, observations, repairs, etc.

PERFORMANCE GUIDE:

1. Obtain current data from notes, technical reports, and service reports to be incorporated in laboratory notebook.
2. Log information into notebook according to categories:
   a. Repairs
   b. Tube characteristics
   c. High voltage power supply characteristics
   d. Low voltage power supply characteristics
   e. Model number and make of equipment.
3. Date recorded information.
4. Initial recorded information.
5. Review notebook with supervisor.
6. Obtain "witness" signature.
7. Review notebook periodically.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING RECORDS

PERFORMANCE OBJECTIVE NO. 2

TASK: Prepare operational log book

STANDARD: Operational log book must be dated and initialed. Data must include characteristics of tube, low voltage, and/or excitation system.

CONDITIONS FOR PERFORMANCE OF TASK:

Operational log book

PERFORMANCE GUIDE:

1. Observe operation of system or component of system to be documented.
2. Record data which may include:
   a. Beam diameter
   b. Beam divergence
   c. Beam power
   d. Mode change
   e. Gas pressure
   f. Wave length
   g. Pulse rate
   h. Pulse width
   i. High voltage characteristics
   j. Low voltage characteristics
   k. Log time (number of hours operated).
3. Analyze data.
4. Record summary analysis.
5. List start-up and shut-down operator.
6. Date logged information.
7. Initial logged information.
8. Submit operational log book for review.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING RECORDS

PERFORMANCE OBJECTIVE NO. 3

TASK: Prepare shop drawing(s)

STANDARD: Completed shop drawings must contain latest engineering revisions and must be approved by engineering department.

CONDITIONS FOR PERFORMANCE OF TASK:

Copy of latest engineering revisions
Shop drawings

PERFORMANCE GUIDE:

1. Obtain drawings of laser system.
2. Acquire copy of latest engineering revisions to laser system.
3. Inspect shop drawings.
4. Change shop drawing(s) to comply with engineering revisions.
5. Obtain approval of shop drawing(s) from engineering department.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING RECORDS

PERFORMANCE OBJECTIVE NO. 4

TASK: Prepare equipment requisition

STANDARD: Equipment requisition must be signed and dated and must contain all information necessary to fulfill request.

CONDITIONS FOR PERFORMANCE OF TASK:

Requisition
Equipment details

PERFORMANCE GUIDE:

1. Obtain blank requisition form.
2. Complete required information as necessary:
   a. Exact type and size of equipment needed
   b. Serial numbers if applicable
   c. Name of project for which equipment is needed
   d. Date by which equipment is needed
   e. Supplier's name
   f. Supplier's address
   g. Price of equipment
   h. Exact delivery location.
3. Sign requisition form as necessary.
4. Date requisition form.
5. Obtain authorized signature of supervisory personnel.
6. Dispatch requisition according to established facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING RECORDS

PERFORMANCE OBJECTIVE NO. 5

TASK: Prepare service report

STANDARD: Completed service report must be signed and must include: descriptions of work performed; results of work; list of all parts worked on and repaired; time spent; and date of repair.

CONDITIONS FOR PERFORMANCE OF TASK:

Parts inventory
Service report
Service request

PERFORMANCE GUIDE:

1. Record date.
2. Record laser malfunction and symptoms.
3. Note and record all serial numbers of equipment worked on.
4. Record time spent in repair and/or maintenance of laser.
5. Describe all work performed.
6. List all parts used to repair system with part numbers and price.
7. Describe result(s) of service to laser system.
8. Provide procedure to eliminate recurrence of problems.
9. Sign completed service report.
10. Submit completed service report to appropriate department according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING RECORDS

PERFORMANCE OBJECTIVE NO. 6

TASK: Prepare expense report

STANDARD: Completed expense report must be signed and dated. Report must include totaled amounts of itemized cash expenses and itemized charged expenses. Receipts must be attached to report.

CONDITIONS FOR PERFORMANCE OF TASK:

Expense report form
Receipts

PERFORMANCE GUIDE:

1. Obtain expense report form.
2. Fill in name and date.
3. Fill in report period dates.
4. Fill in customer facility name and address.
5. List expenses incurred during specified report period for:
   a. Mileage for personal vehicle
   b. Tolls
   c. Parking
   d. Plane fare
   e. Car rental
   f. Lodging
   g. Meals
   h. Telephone
   i. Miscellaneous.
6. Attach receipts to expense report.
7. Indicate on all expenses whether:
   a. Expense was charged to company (credit cards), or
   b. Expense was paid in cash.
8. Total all charged expenses.
9. Total all cash receipts.
10. Sign and date expense report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING RECORDS

PERFORMANCE OBJECTIVE NO. 7

TASK: Update technical manual

STANDARD: Changes in technical manual must be approved by engineering department. Manual must contain latest changes in laser system; all changes must be dated and initialed.

CONDITIONS FOR PERFORMANCE OF TASK:

Laser manufacturer's design update
Notes on changes
Technical manual

PERFORMANCE GUIDE:

1. Collect notes on laser system changes.
2. Submit proposed changes (per design update) to engineering department prior to making changes.
3. Add changes to manual.
4. Date changes.
5. Initial changes.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: INSTALLING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 8

TASK: Install gaseous laser system

STANDARD: Primary and secondary water lines must be connected and must not leak. Water must flow through laser head within temperature range specified in laser system service manual. Voltage connectors and cables must be tight with no open circuits. Insulation must be intact. Current must run within recommended range according to laser system service manual. Shield gases and gas supply must flow as specified in laser system service manual. Established safety policies and procedures must be followed. Any system damage must be reported to authorized personnel. Laser power output and beam characteristics must meet laser system specifications. Caution signs must be put in place.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Manufacturer's installation manual
Caution signs	Operational log book
Helium neon alignment laser	Oscilloscope
Laser power meter	Safety glasses
Laser safety goggles for specified wave length	Safety policies and procedures
	Thermometer
Laser system service manual	VOM

PERFORMANCE GUIDE:

1. Inspect shipping crate(s) for damage.
2. Report any damage to authorized personnel.
3. Unpack crate(s).
4. Verify parts inventory with parts received.
5. Read manufacturer's installation manual.
6. Place laser system in accordance with laser system specifications.
7. Post caution signs.
8. Put on safety glasses.
9. Level laser head in accordance with manufacturer's installation manual.
10. Tie-down laser as required.

DUTY: INSTALLING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 8

TASK: Install gaseous laser system (Continued)

11. Remove safety glasses.
12. Put on laser safety goggles.
13. Align laser internally.
14. Level and tie-down work station as required.
    a. Turn on helium neon alignment laser.
    b. Align helium neon laser coincident to laser beam.
    c. Place work station in line with helium neon beam.
       Note: Beam must hit centers of entry and exit holes in enclosure.
    d. Level jacks at all corners of work station.
    e. Install cover at exit hole if necessary.
       CAUTION: EXIT HOLE MUST BE CLOSED AT ALL TIMES EXCEPT FOR ALIGNMENT OR INSTALLATION PROCEDURES.
    f. Align external optics.
15. Connect shield gas(es) as required in accordance with manufacturer's installation instructions.
16. Connect input and output secondary water lines as required.
17. Connect input and output primary water lines as required.
18. Connect gas supply hose(s) as required in accordance with manufacturer's installation instructions.
    CAUTION: DO NOT OPEN GAS VALVE UNTIL AUTHORIZED TO DO SO.
19. Connect electrical connections in accordance with local electrical codes and regulations and manufacturer's installation instructions.
20. Tighten all connections.
21. Remove obstacles from beam path.
22. Place beam stop at end of beam path.
23. Review safety policies and procedures.
24. Energize laser.
25. Note that laser tube discharges.
    a. Troubleshoot beam generation system if tube does not discharge.
26. Set current to recommend running range according to laser system specifications.
27. Check mode.
    a. Adjust internal optics if necessary.
28. Measure output power.
29. Record reading in operational log book.
30. Measure laser stability.
31. Record reading in operational log book.
32. Remove laser safety goggles.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: INSTALLING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 9

TASK: Install solid state (YAG) laser system

STANDARD: Primary and secondary water lines must be connected and must not leak. Water must flow through laser head within temperature range specified in laser system service manual. Voltage connectors and cables must be tight and unbroken. Current must run within recommended range according to laser system specifications. Laser power output and beam characteristics must meet laser system specifications. Caution signs must be in place. Any damage to system must be reported to authorized personnel.

CONDITIONS FOR PERFORMANCE OF TASK:

- Standard tool kit
- Black light
- Caution signs
- Distilled water
- Laser power meter
- Laser pulse detector
- Laser safety goggles for specified wave length
- Laser system service manual
- Manufacturer's installation manual
- Operational log book
- Oscilloscope
- Phosphor screen
- Safety policies and procedures
- Thermometer
- VOM

PERFORMANCE GUIDE:

1. Inspect shipping crate for damage.
2. Report any damage to authorized personnel.
3. Unpack laser power supply and cooler from shipping crate.
4. Verify parts inventory with parts received.
5. Read manufacturer's installation manual.
6. Place laser system in accordance with laser system specifications.
7. Post caution signs.
8. Test water temperature to see that it is in specified range indicated in laser system service manual.
   a. Proceed with step #9 if water temperature is in recommended range.
   b. Increase flow of water if temperature is too high, or
   c. Arrange for external chilling system for water intake.
9. Connect input and output secondary water lines to heat exchanger.

DUTY: INSTALLING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 9

TASK: Install solid state (YAG) laser system (Continued)

10. Connect input and output primary (closed loop) water lines to laser head.
11. Connect laser high voltage connector from power supply to laser head.
12. Tighten connector securely.
13. Connect interlock cable from RF driver to laser head.
14. Connect RF BNC cable from RF driver to laser head.
15. Connect input voltage power cable to laser power supply.
16. Inspect system for any loose or broken connections before applying power.
    a. Tighten loose connections if necessary.
    b. Replace broken connections if necessary.
    CAUTION: DO NOT APPLY POWER UNTIL AUTHORIZED TO DO SO.
17. Fill cooler reservoir tank with distilled water.
18. Plug voltage input cable into wall source.
19. Turn on cooler switch.
20. Note that water is circulating through laser head.
    a. Add more water if low level light is lit.
21. Review safety policies and procedures.
22. Remove obstacles from beam path.
23. Place beam stop at end of beam path.
24. Put on laser safety goggles.
25. Energize laser.
26. Note that lamp ignites.
    a. Troubleshoot beam generation system if lamp does not ignite.
27. Set current to recommended running range according to laser system service manual.
28. Place black light and phosphor screen in front of beam expander.
29. Observe that laser is operating in specified mode.
    a. Troubleshoot beam generation system if laser is not operating in specified mode.
30. Check mode.
    a. Adjust internal optics if necessary.
31. Measure output power.
32. Record reading in operational log book.
33. Measure laser stability.

DUTY: INSTALLING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 9

TASK: Install solid state (YAG) laser system (Continued)

34. Record reading in operational log book.
35. Remove laser safety goggles.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 10

TASK: Inspect reflecting mirrors and focusing optics

STANDARD: All burns, discolorations, dust, film, chips, cracks, pits, or scratches must be identified. Reinstalled optics must be aligned.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Lens cleaner
Instructions for cleaning optics	Lens tissue
Laser system service manual	Service report

PERFORMANCE GUIDE:

1. Shut down laser system.
2. Disconnect main power.
3. Wash hands.
4. Review manufacturer's specifications for position and access to optics.
5. Gain access to optic system.
6. Identify surface contamination:
   a. Burned coatings
   b. Discolorations
   c. Dust
   d. Film
   e. Chips/cracks/pits
   f. Scratches
7. Clean or replace optics.
8. Reinstall optics in system.
9. Realign optics.
10. Connect main power.
11. Return laser system to service.
12. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 11

TASK: Clean optics

STANDARD: Optics must be aligned and must be free of any contaminants. Manufacturer's instructions must be followed for specific types of optics being cleaned.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Lens paper
Duster	Manufacturer's instructions for specific optics
Isopropyl alcohol	
Laser system service manual	Service report

PERFORMANCE GUIDE:

1. Review laser system service manual for access to optics.
2. Review manufacturer's instructions for cleaning specific optics.
3. Wash hands.
4. Remove front cap.
5. Remove set screws from rear cap.
6. Remove rear cap.
   For stationary mirrors:
   a. Blow dust off mirror.
   b. Saturate lens paper with isopropyl alcohol.
   c. Wipe mirrors according to manufacturer's instructions.
   For removable mirrors:
   a. Remove mirror mount(s).
   b. Blow dust off mirror.
   c. Saturate lens paper with isopropyl alcohol.
   d. Wipe mirrors according to manufacturer's instructions.
   e. Return mirror mount(s) to laser tube.
   f. Replace mirror mount(s).
   g. Align laser optics.
7. Replace front cap on laser housing.
8. Replace rear cap on housing.
9. Tighten set screws on rear cap.

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 11

TASK: Clean optics (Continued)

10. Test laser operation.
11. Return laser system to service.
12. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 12

TASK: Verify Q-switch in YAG laser system

STANDARD: Q-switch must pass beam in CW (continuous wave) position and must block beam in external mode. Laser Q-switch power must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Methyl alcohol
Black light	Phosphor screen
Laser safety goggles for specified wave length	Q-switch
	RF power meter
Laser system service manual	Service report
Lens tissue	

PERFORMANCE GUIDE:

1. Review laser system service manual.
2. Put on laser safety goggles.
3. Shut down laser system.
4. Disconnect main power.
5. Disconnect RF input cable from Q-switch.
6. Close shutter.
7. Remove Q-switch assembly from laser rail.
8. Inspect both optical surfaces of Q-switch quartz block for burns or scratches.
   a. Replace Q-switch if burns or scratches are observed.
9. Inspect both optical surfaces of Q-switch quartz block for dirt or film.
   a. Clean optical surfaces if dirt or film is observed.
10. Replace Q-switch assembly onto laser rail.
11. Secure Q-switch.
12. Place black light and phosphor screen in front of output beam expander.
13. Energize laser.
14. Open shutter.
15. Place RF mode switch in CW (continuous wave) position.
    Note: Beam will appear on screen.
16. Place RF mode switch in external position.

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 12

TASK: Verify Q-switch in YAG laser system (Continued)

17. Observe screen for disappearance of beam.
    a. Proceed with step #18 if beam has disappeared.
    b. Proceed as follows if beam has not disappeared.
        (1) Test RF power level on Q-switch.
        (2) Adjust bragg angle.
        (3) Replace Q-switch if neither (1) or (2) results in beam disappearance.
18. Close shutter.
19. Remove black light and phosphor screen.
20. Remove laser safety goggles.
21. Return laser system to service.
22. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 13

TASK: Verify polarizer in YAG laser system

STANDARD: TEM_{00} (transverse electromagnetic mode) output must be stable with minimum insertion loss. Optical plates must be free of dirt, scratches, and film.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Polarizer
Black light	Phosphor screen
Laser safety goggles for specified wave length	Service report

PERFORMANCE GUIDE:

1. Put on laser safety goggles.
2. Energize laser.
3. Set laser to normal operating current in TEM_{00} (transverse electromagnetic mode).
4. Close shutter.
5. Place black light and phosphor screen in front of output beam expander.
6. Remove cover on polarizer assembly.
7. Remove polarizer plate block from polarizer assembly.
8. Inspect both front and back optical plates for:
   a. Burns
   b. Scratches
   c. Dirt
   d. Film
9. Replace defective polarizer plate(s) if necessary.
10. Open shutter.
11. Peak laser rear mirror for best round multimode beam structure.
12. Insert polarizer plate block into polarizer assembly.
    Note: Beam mode structure on phosphor screen will be displayed as a cross image.
13. Peak rear mirror to sharpen cross image.
14. Close shutter.
15. Shut down laser system.
16. Remove laser safety goggles.

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 13

TASK: Verify polarizer in YAG laser system (Continued)

17. Remove black light and phosphor screen from laser output.
18. Return laser system to service.
19. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 14

TASK: Test power/energy output at source

STANDARD: Power/energy output at source not in conformance with laser system specifications must be identified.

CONDITIONS FOR PERFORMANCE OF TASK:

Laser safety goggles for specified wave length	Operational log book
Laser system service manual	Power meter/energy meter
	Service report

PERFORMANCE GUIDE:

1. Put on laser safety goggles.
2. Align power meter/energy meter with beam path.
3. Check laser system service manual for recommended power output.
4. Set power meter range.
5. Zero power meter.
6. Energize laser.
7. Record power reading/energy reading in operational log book.
8. Determine if power output is within recommended range.
   a. Proceed to step #9 if power output is in conformance with laser system service manual.
   b. Troubleshoot beam generation system if power output is not within specified range.
9. Shut down laser system.
10. Remove power meter from optical path.
11. Remove laser safety goggles.
12. Return laser system to service.
13. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 15

TASK: Verify thermal switch operation

STANDARD: Thermal switches not activating at temperature specified in laser system specifications must be identified and replaced.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Laser system service manual
Heat gun	Service report
High voltage probe	Shorting bar
Laser safety goggles for specified wave length	Thermocouple meter

PERFORMANCE GUIDE:

1. Put on laser safety goggles.
2. Energize laser system.
   CAUTION: DO NOT TURN ON HIGH VOLTAGE POWER SUPPLY.
3. Insert shorting bar.
4. Attach high voltage probe.
5. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
6. Gain access to thermal switch.
7. Attach thermocouple meter to thermal switch.
8. Turn on heat gun and direct air to temperature switch.
9. Observe thermocouple reading when system thermal interlock activates.
10. Compare thermocouple temperature reading to laser system specifications.
    a. Proceed to step #11 if readings are in conformance with laser system specifications.
    b. Proceed as follows if readings are not in conformance until problem has been identified and corrected.
       (1) Replace thermal switch.
       (2) Troubleshoot temperature control system.
11. Remove shorting bar.
12. Remove laser safety goggles.
13. Return laser system to service.
14. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 16

TASK: Test RF power on Q-switch

STANDARD: RF forward and reverse power not in conformance with laser system specifications and/or Q-switch not holding off output beam must be identified.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	RF power meter
BNC cable	Safety glasses
Laser system service manual	Service report
Operational log book	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down RF driver.
3. Disconnect BNC cable from RF output.
4. Connect RF power meter between RF output and Q-switch.
5. Turn on RF driver power.
6. Set meter element to forward direction.
7. Record meter reading in operational log book.
8. Review laser system service manual for recommended setting.
9. Adjust RF power control if necessary.
   a. Replace RF driver if power cannot be adjusted to recommended setting.
10. Set meter element to reverse direction.
11. Record reflective power reading.
    Note: Reflective power must conform to laser system specifications.
12. Determine if reflective power is excessive.
    a. Replace Q-switch, or
    b. Replace RF driver to achieve impedance match.
13. Remove safety glasses.
14. Return laser system to service.
15. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 17

TASK: Change water filter

STANDARD: Water filter assembly must be free of leaks. Cooler flow rate must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	O-ring
Filter	Safety glasses
Laser system service manual	Service report

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Shut down water pump.
4. Remove water filter canister retainer nut.
5. Drop filter canister from top assembly.
6. Remove old filter insert from canister.
7. Drop new filter insert into canister.
8. Insert new O-ring.
9. Seat canister up into top assembly.
10. Tighten retainer nut.
11. Add water to cooler reservoir if necessary.
12. Adjust water flow to recommended rate as specified in laser system service manual.
13. Turn cooler pump on.
14. Check for leaks.
15. Check flow rate.
16. Remove safety glasses.
17. Return laser system to service.
18. Prepare service report.
19. Dispose of defective water filter according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 18

TASK: Change deionizer cartridge holder

STANDARD: Deionizer cartridge holder must not leak coolant. Coolant level must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

- Standard tool kit
- Coolant
- Deionizer cartridge
- High voltage probe
- Laser system service manual
- Safety glasses
- Service report
- Shorting bar
- VOM

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down complete laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to cartridge holder.
8. Close inlet and outlet coolant flow valves.
9. Disconnect deionizer cartridge holder housing.
10. Remove old cartridge from housing.
11. Clean out housing with clean rag.
12. Install new cartridge in housing.
13. Connect cartridge holder housing.
14. Open inlet and outlet coolant valves.
15. Clean up any coolant spillage.
16. Connect main power.
17. Energize laser temperature control system.
18. Check cartridge holder for leaks.
    a. Tighten cartridge in housing if necessary.
19. Replenish lost coolant in cooler reservoir to recommended level specified in laser system service manual.

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 18

TASK: Change deionizer cartridge holder (Continued)

20. Remove shorting bar.
21. Remove safety glasses.
22. Return laser system to service.
23. Prepare service report.
24. Dispose of defective deionizer cartridge according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 19

TASK: Adjust power supply output

STANDARD: Current at power supply output must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Laser system service manual
High voltage probe	Service report
Laser safety goggles for specified wave length	Shorting bar
	VOM

PERFORMANCE GUIDE:

1. Put on laser safety goggles.
2. Shut down complete laser system.
3. Disconnect main power.
4. Remove power supply cover.
5. Insert shorting bar.
6. Attach high voltage probe.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Connect VOM in series with laser tube.
8. Set VOM range.
9. Zero meter.
10. Check laser system service manual for specified power output.
11. Remove shorting bar.
12. Connect main power.
13. Energize laser system.
14. Note meter reading.
15. Adjust current POT (potentiometer) to laser system specifications.
16. Shut down complete laser system.
17. Disconnect main power.
18. Disconnect VOM.
19. Replace and secure power supply cover.

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 19

TASK: Adjust power supply output (Continued)

20. Remove laser safety goggles.
21. Return laser system to service.
22. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 20

TASK: Align complete beam delivery path

STANDARD: Laser beam must be centered to each beam bender mirror. Laser beam must be centered to focusing lens. Power reading at work surface must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Laser power meter
Adjustable jack stands	Laser safety goggles for specified wave length
Black light	
Cross hair	Laser system service manual
End cap pin holes	Phosphor screen
Helium neon alignment laser	Service report

PERFORMANCE GUIDE:

1. Put on laser safety goggles.
2. Remove work surface focusing lens and guard shield.
3. Center beam to first beam bender mirror.
4. Center beam to next beam bender by adjusting previous beam bender mirror adjustments.
5. Continue until all beam bender mirrors are adjusted.
6. Screw cross hair in focusing lens mount.
7. Center beam in cross hair using previous beam bender mirror mount adjustments.
8. Remove cross hairs.
9. Align power meter with beam path.
10. Zero meter.
11. Set meter for output power range specified in laser system service manual.
12. Energize laser.
13. Adjust laser power output to laser system specifications.
14. Remove power meter.
15. Replace work surface focusing lens and guard shield.
16. Remove laser safety goggles.
17. Return laser system to service.
18. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 21

TASK: Align laser cavity optics

STANDARD: Laser must perform in conformance with laser system specifications. Laser beam must be centered to focusing lens. Power reading at work surface must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

- Standard tool kit
- Adjustable jack stands
- Black light
- Cross hair
- End cap pin holes
- Expander lens
- Helium neon alignment laser
- Laser power meter
- Laser safety goggles for specified wave length
- Laser system specifications
- Phosphor screen
- Service report

PERFORMANCE GUIDE:

1. Put on laser safety glasses.
2. Shut down laser power supply.
3. Shut down power to cooler.
4. Install one end cap pin hole on both left and right mirror mounts.
5. Position helium neon laser 10 inches in front of front mirror mount.
6. Position phosphor screen 10 inches in front of front mirror mount.
7. Remove Q-switch from rail on YAG lasers.
8. Adjust helium neon laser in both horizontal and vertical axis until red beam shines through both pin holes and appears on screen.
9. Loosen lock clamps on both left and right mirror adjustments.
10. Remove pin holes from mirror mounts.
11. Locate group of 4 reflections in various positions shining back on neon laser front plate.
    Note: Fundamental red output beam is your center reference beam.

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 21

TASK: Align laser cavity optics (Continued)

12. Identify 4 reflections as follows:
    a. Rear mirror
    b. Front mirror
    c. Rear face of crystal rod
    d. Front face of crystal rod.
13. Rotate crystal rod and/or adjust laser pot assembly so front and rear rod reflections superimpose themselves on fundamental axis beam.
14. Adjust rear mirror reflection axis at least 3 or 4 turns off axis so laser will not emit beam.
15. Energize laser and cooler to ignite lamp.
16. Adjust pump current up and down from 15 amps to 35 amps and observe that:
    a. Both rod reflections remain centered on fundamental axis. Proceed to b. if reflections are not centered.
    b. Rotate rod adjusting pot assembly horizontally or slightly adjust red laser position until condition a. is satisfied.
17. Lock rod and pot assembly in position.
    Note: Do not move neon laser anymore, as this is the reference axis.
18. Adjust front mirror so its reflection is centered on red beam reference axis.
19. Lock down mirror adjustments.
20. Place black light and phosphor screen in front of laser.
21. Turn black light on to illuminate phosphor screen.
22. Install expander lens on front mirror mount.
23. Adjust pump current to running current setting recommended in laser system specifications.
24. Adjust rear mirror reflection to superimpose on reference axis.
    Note: On YAG lasers, 1.06a YAG beam should appear on phosphor screen with red beam in center.
25. Remove black light and screen from front of laser.
26. Measure output power.
27. Peak to maximum power with rear mirror adjustment.
28. Lock rear mirror.
29. Reduce pump current below threshold.
30. Reinstall Q-switch on YAG lasers.
31. Center its reflections on reference axis.
32. Lock down.

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 21

TASK: Align laser cavity optics (Continued)

33. Install aperture for specified mode structure.
34. Remove laser safety goggles.
35. Set power supply to running current.
36. Return laser system to service.
37. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO: 22

TASK: Inspect cooler fittings

STANDARD: All internal contaminents, leaks, and cross threaded fittings must be identified.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
High voltage probe	Shorting bar
Safety glasses	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down complete laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to fittings.
8. Examine inside of transparent hose at fittings for contaminent build-up.
9. Examine fittings for coolant leaks.
   a. Replace fittings if necessary.
10. Examine fittings for cross threading.
    a. Replace fittings if necessary.
11. Remove shorting bar.
12. Connect main power.
13. Remove safety glasses.
14. Return laser system to service.
15. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 23

TASK: Inspect air circulating filter(s)

STANDARD: Air circulating filters that are dirty, oily, or worn must be identified. Filters must be installed in conformance with laser system specifications and replaced filters must be of the same size and type as recommended in laser system service manual.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
High voltage probe	Service report
Laser system service manual	Shorting bar
Light source	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Locate air filter(s).
8. Remove filter(s) from system.
9. Hold filter up to light source.
10. Examine filter for:
    a. Build-up of dirt and/or oil
    b. Signs of filter deterioration and/or wear.
11. Clean or replace filter as necessary.
12. Repeat steps #9 and #10 for each air circulating filter within laser system.
13. Reinstall air filter(s).
14. Remove shorting bar.
15. Connect main power.

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 23

TASK: Inspect air circulating filter(s) (Continued)

16. Remove safety glasses.
17. Return laser system to service.
18. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 24

TASK: Clean air circulating filter(s)

STANDARD: Air circulating filters must be free of visible dirt and oil and must be installed in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
Filter coating	Shorting bar
High voltage probe	Soap
Hot air gun	Sink
Laser system service manual	Water
Safety glasses	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Locate air filter(s).
8. Remove filter(s) from system.
9. Place filter(s) in sink.
10. Wash filter(s) with mild soap and water.
11. Rinse clean filter(s) with tap water.
12. Dry filter(s) with hot air gun.
13. Coat filter(s) with filter coating, according to laser system specifications.
14. Reinstall air filter(s) to system.
15. Remove shorting bar.
16. Connect main power.
17. Remove safety glasses.
18. Return laser system to service.
19. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 25

TASK: Replace air circulating filter(s)

STANDARD: Air circulating filter(s) must be replaced with filter(s) recommended in laser system service manual.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Air circulating filter(s)	Service report
High voltage probe	Shorting bar
Laser system specifications	

PERFORMANCE GUIDE:

1. Review laser system specifications for type and size of replacement filter recommended.
2. Put on safety glasses.
3. Shut down laser system.
4. Disconnect main power.
5. Insert shorting bar.
6. Attach high voltage probe.
7. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
8. Locate air filter(s).
9. Remove filter(s) from system.
10. Discard used filter(s).
11. Install new filter(s) in system.
12. Remove shorting bar.
13. Connect main power.
14. Remove safety glasses.
15. Return laser system to service.
16. Prepare service report.
17. Dispose of defective filter(s) according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 26

TASK: Measure power/energy output at work surface

STANDARD: Measured power/energy output not in conformance with laser system specifications must be identified.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Oscilloscope
Laser safety goggles for specified wave length	Power meter/energy meter
Laser system service manual	Pulse detector
	Service report

PERFORMANCE GUIDE:

1. Put on laser safety goggles.
2. Remove work surface focusing lens and shield.
3. Align power meter/energy meter with beam path.
4. Zero meter.
5. Set meter for output power range.
6. Energize laser.
7. Note power reading/energy reading.
8. Compare reading to laser system specifications:
   a. Proceed to step #9 if power output is within laser system specifications.
   b. Troubleshoot beam generation system if power output is not within laser system specifications.
9. Shut down laser.
10. Remove power meter.
11. Replace focus lens and shield.
12. Remove laser safety goggles.
13. Return laser system to service.
14. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 27

TASK: Verify safety interlock system operation

STANDARD: Laser power supply must shut down when an interlocked cover is removed.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Laser system service manual
Interlock system schematic	Service report
Laser safety goggles for specified wave length	VOM

PERFORMANCE GUIDE:

1. Review interlock system schematic.
2. Put on laser safety goggles.
3. Energize laser system.
4. Set power to recommended operating current according to laser system specifications.
5. Remove interlocked cover from laser to initiate interlock operation.
6. Determine if laser power supply has automatically shut down.
   a. Proceed as follows if laser power supply has not shut down:
      (1) Check interlock switch with VOM.
      (2) Check wiring to switch.
      (3) Check interlock relay.
      (4) Check control electronics to relay.
      (5) Replace defective component(s).
7. Replace interlocked cover.
8. Determine if power supply comes on and beam is restored.
   a. Repeat step #6 if not in conformance with laser system specifications.
9. Repeat steps #5-8 for all interlock devices.
10. Remove laser safety goggles.
11. Return laser system to service.
12. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 28

TASK: Verify lens focal length

STANDARD: Lens focal length must correspond to manufacturer's stamped distance on focusing lens.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Measurement medium (thermoflax paper, etc.)
Focusing lens guard shield	Measuring scale
Laser safety goggles for specified wave length	Service report

PERFORMANCE GUIDE:

1. Put on laser safety goggles.
2. Remove focusing lens guard shield.
3. Measure distance from focus lens to work surface with measuring scale.
   Note: Be careful not to touch optic surface.
4. Place measurement medium on work surface table under focusing lens.
5. Adjust laser for low power output.
6. Energize laser briefly to get focusing lens spot size on measurement medium.
7. Jog work table over to new section of measurement medium.
8. Adjust focusing fixture up 1/4 inch.
9. Energize laser briefly to burn laser focusing lens spot size.
10. Jog work table again over to new section of measurement medium.
11. Move focusing lens fixture down 1/2 inch.
12. Energize laser briefly to burn spot size.
13. Compare all spot sizes on measurement medium.
14. Determine if smallest spot size corresponds to stamped distance on focusing lens.
    a. Replace focusing lens if focal length does not correspond to specified focal length.
15. Remove laser safety goggles.
16. Return laser system to service.
17. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: MAINTAINING LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 29

TASK: Verify repetition rate

STANDARD: Repetition rate must be set according to laser system specification for particular application.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Laser system specifications	Service report
Oscilloscope/frequency counter	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Energize laser system.
   CAUTION: LEAVE HIGH VOLTAGE POWER SUPPLY OFF.
3. Gain access to system pulse generator.
4. Connect oscilloscope/frequency counter to output of pulse generator.
5. Activate pulse generator.
6. Adjust pulse generator to laser system specifications using oscilloscope/frequency counter if not within specification.
7. Remove safety glasses.
8. Return laser system to service.
9. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 30

TASK: Identify symptoms of problem

STANDARD: Problem must be localized to specific inoperative system within total laser system. Laser operator must be questioned on laser performance and maintenance records must be reviewed.

CONDITIONS FOR PERFORMANCE OF TASK:

- Laser operator
- Maintenance records
- Operational log book

PERFORMANCE GUIDE:

1. Review maintenance records and operational log book for laser system.
2. Discuss maintenance service of laser with maintenance technician if necessary.
3. Discuss problem with laser operator.
4. Ask laser operator the following questions:
   a. Is the lamp igniting?
   b. Does the lamp remain lit?
   c. Is the cooler functioning?
   d. Is the RF functioning?
5. Localize problem to general area of concern:
   a. Beam generation system
   b. Temperature control system
   c. Excitation system
   d. Low voltage power supply
   e. RF system
   f. Vacuum system
   g. Gas supply system.
6. Troubleshoot area where concern is focused.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 31

TASK: Troubleshoot temperature control system

STANDARD: Temperature control system not in accordance with laser system specifications must be identified. Fault indicator lights must be operative but must not be indicating malfunction of system.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
Laser system service manual	Thermometer/thermocouple meter
Safety glasses	

PERFORMANCE GUIDE:

1. Review laser system service manual.
2. Put on safety glasses.
3. Energize laser system.
   CAUTION: DO NOT ACTIVATE HIGH VOLTAGE.
4. Check temperature control panel lights for defects.
   a. Replace defective bulb(s).
   b. Repair other defect(s).
5. Adjust panel to laser system specifications.
6. Check each fault indicated by corresponding panel light as follows, and repair or adjust until problem has been corrected.

   <u>No coolant flow indicated</u>
   (a) Check coolant pump.
   (b) Examine wiring.
   (c) Check fuses.
   (d) Verify circuit breaker operation.
   (e) Check coolant fluid level.
   (f) Verify operation of flow switch.
   (g) Verify operation of temperature control switch.

   <u>Over temperature</u>
   (a) Check water temperature.
   (b) Check level of cooler refrigerant.
   (c) Verify operation of coolant shut-off.
   (d) Verify operation of compressor.
   (e) Clean secondary coolant filter.
   (f) Verify operation of temperature indicator switch.

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 31

TASK: Troubleshoot temperature control system (Continued)

Low Coolant Flow

(a) Verify operation of flow indicator.
(b) Clear coolant line of restriction(s).
(c) Clean secondary coolant filter.

7. Determine that all fault indicator panel lights are off.
8. Remove safety glasses.
9. Return laser system to service.
10. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 32

TASK: Troubleshoot beam generation system

STANDARD: Laser power output, threshold current, RF power and laser stability must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Operational log book
Laser power meter	Oscilloscope
Laser safety goggles for specified wave length	Pulse detector
	RF meter
Laser system service manual	Service report

PERFORMANCE GUIDE:

1. Determine required power output range from laser system specifications.
2. Insert laser power meter in beam path.
3. Put on laser safety goggles.
4. Energize laser.
5. Measure laser output.
6. Record reading in operational log book.
7. Measure laser threshold current.
8. Record reading in operational log book.
9. Determine if laser output power and threshold current are in conformance with laser system specifications.
   a. Proceed to step #10 if readings are in conformance with specifications.
   b. Proceed through steps below until problem has been identified and corrected if reading is not in conformance with specifications:
      (1) Shut down laser power supply.
      (2) Inspect focusing optics.
          (a) Clean optics.
      (3) Align optics.
      (4) Verify Q-switch in YAG laser system.
      (5) Verify polarizer in YAG laser system.
      (6) Replace lamp jacket if necessary.
      (7) Replace flashlamp if necessary
      (8) Replace crystal rod if necessary
      (9) Replace gold cavity if necessary.

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 32

TASK: Troubleshoot beam generation system (Continued)

(10) Replace gaseous tube if necessary.
(11) Clean or replace mirror(s).
(12) Replace mirror mount if necessary.
(13) Verify peak pulse power.
(14) Verify frequency of pulse train.

10. Measure RF power.
11. Record reading in operational log book.
12. Determine if RF power is in conformance with laser system specifications.
    a. Proceed to step #13 if reading is in conformance with specifications.
    b. Proceed through steps below until problem has been identified and corrected if reading is not in conformance with specifications:
        (1) Replace cable.
        (2) Replace controller box.
        (3) Repair low voltage power supply.
13. Measure laser stability with pulse detector and oscilloscope.
14. Determine if stability is within laser system's specified range.
    a. Proceed to step #15 if stability is within specified range.
    b. Proceed through steps below until problem has been identified and corrected.
        (1) Check AC ripple percentage on laser supply.
        (2) Check lamp cooler water for air bubbles.
        (3) Check laser alignment.
            (a) Realign if necessary.
        (4) Check for air leaks in primary lines.
15. Remove laser safety goggles.
16. Return laser system to service.
17. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 33

TASK: Troubleshoot excitation system

STANDARD: All defective excitation system components must be identified.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
High voltage probe	Service report
Laser system service manual	Shorting bar
Oscilloscope	VOM

PERFORMANCE GUIDE:

1. Review laser system service manual for recommended power readings.
2. Put on safety glasses.
3. Connect high voltage probe with oscilloscope to output of high voltage power supply.
4. Connect high voltage power supply.
5. Turn on high voltage power supply.
6. Measure output voltage.
7. Confirm power supply failure.
8. Turn off power supply.
9. Discharge power supply.
10. Disconnect power supply.
11. Insert shorting bar.
12. Attach high voltage probe.
13. Measure voltage remaining in system.
    CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
14. Remove screws from power supply cover.
15. Remove cover from power supply.
16. Remove power supply from extrusion.
17. Set VOM at recommended range.
18. Zero VOM.
19. Measure excitation system components proceeding through steps #20-28 until problem has been identified and corrected.
20. Measure high voltage diode(s) resistances.
    a. Replace defective diode(s).

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 33

TASK: Troubleshoot excitation system (Continued)

21. Measure high voltage capacitors.
    a. Replace defective capacitors.
22. Test resistors.
    a. Replace defective resistors.
23. Test SCR (silicon control rectifier).
    a. Replace defective SCR.
24. Ohm high voltage cables.
    a. Replace defective cable(s).
25. Ohm fuses.
    a. Replace defective fuse(s).
26. Ohm three-phase contactor.
    a. Replace defective three-phase contactor.
27. Ohm high voltage dump contactor.
    a. Replace defective dump contactor.
28. Inspect boards.
29. Ohm traces for continuity.
    a. Repair broken traces.
    b. Replace defective boards.
30. Return power supply to extrusion.
31. Replace and secure cover on power supply.
32. Remove shorting bar.
33. Connect main power.
34. Energize laser.
35. Confirm excitation system operation.
    a. Troubleshoot low voltage power supply if excitation system is not operating according to laser system specifications.
    b. Return to manufacturer for repair if steps #1-34 do not correct problem.
36. Remove safety glasses.
37. Return laser system service if applicable.
38. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 34

TASK: Troubleshoot low voltage power supply

STANDARD: All defective low voltage power supply components must be identified.

CONDITIONS FOR PERFORMANCE OF TASK:

- Standard tool kit
- High voltage probe
- Laser safety goggles for specified wave length
- Laser system service manual
- Safety glasses
- Schematic of low voltage circuits
- Service report
- Shorting bar
- VOM

PERFORMANCE GUIDE:

1. Review schematic of low voltage circuits and laser system service manual for recommended power readings.
2. Put on safety glasses.
3. Connect VOM to low voltage power supply output.
4. Connect main power.
5. Energize laser.
6. Measure output voltage.
7. Confirm power supply failure.
8. Shut down laser system.
9. Disconnect main power.
10. Insert shorting bar.
11. Attach high voltage probe.
12. Measure voltage remaining in system.
    CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
13. Remove screws from power supply cover.
14. Remove cover from power supply.
15. Remove low voltage power supply from extrusion.
16. Set VOM range at recommended setting.
17. Zero VOM.
18. Measure low voltage components proceeding through steps #19-29 until problem has been identified and corrected.
19. Measure fuse resistance.
    a. Replace defective fuse.

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 34

TASK: Troubleshoot low voltage power supply (Continued)

20. Measure transformer resistance.
    a. Replace defective transformer.
21. Measure resistance of diode(s).
    a. Replace defective diode(s).
22. Measure resistance of resistors.
    a. Replace defective resistors.
23. Measure capacitors.
    a. Replace defective capacitors.
24. Reset VOM range at recommended setting.
25. Remove shorting bar.
26. Connect main power.
27. Energize laser.
28. Measure voltage at output of current regulator.
    a. Replace defective current regulator.
29. Confirm low voltage power supply operation.
    a. Replace low voltage power supply if power supply is not operating according to laser system specifications.
30. Return power supply to extrusion.
31. Replace and secure cover on power supply.
32. Confirm low voltage power operation.
    a. Troubleshoot excitation system if necessary.
33. Remove safety glasses.
34. Return laser system to service.
35. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 35

TASK: Troubleshoot RF system

STANDARD: Specific problems causing laser beam not holding off in external mode and YAG laser not Q-switching in conformance with peak power in internal mode as specified in laser system service manual must be identified.

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CONDITIONS FOR PERFORMANCE OF TASK:

- Standard tool kit
- Black light
- BNC cable
- Expander lens
- Laser safety goggles for specified wave length
- Laser system service manual
- Oscilloscope
- Phosphor screen
- Pulse detector
- RF power meter
- Service report

PERFORMANCE GUIDE:

1. Review laser system service manual.
2. Put on laser safety goggles.
3. Energize laser and RF system.
4. Close shutter.
5. Place black light and phosphor screen in front of output mirror.
6. Install expander lens on front mirror mount.
7. Open shutter and observe that round beam appears on screen.
8. Turn RF mode switch to external position.
9. Verify disappearance of beam from screen.
   a. Proceed as follows beam disappears from screen:
      (1) Verify RF power.
      (2) Adjust bragg angle.
      (3) Replace Q-switch on YAG laser.
      (4) Replace RF driver.
10. Turn RF mode switch to CW (continuous wave) position.
11. Verify reappearance of beam on screen.
    a. Proceed as follows until beam reappears on screen.
       (1) Check controller box and replace if necessary.
       (2) Check mode switch and replace if necessary.
12. Turn RF mode switch to internal position.

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 35

TASK: Troubleshoot RF system (Continued)

13. Set switch to desired repetition rate.
14. Connect pulse detector on rear mirror mount.
15. Connect BNC cable from pulse detector to oscilloscope.
16. Verify that pulses appear on scope screen, and agree with switch setting.
    a. Proceed as follows until pulses appear.
        (1) Verify controller box operation.
        (2) Verify RF driver output.
        (3) Check for beam holdoff at external mode.
        (4) Check for open or shorted BNC cable.
17. Check RF reflective power on RF meter.
    a. Proceed as follows until RF reflective power is within laser system specifications.
        (1) Match 50 MHZ Q-switch to RF driver box on YAG laser.
        (2) Replace Q-switch on YAG laser.
        (3) Replace RF driver.
        (4) Replace BNC cable.
18. Close shutter.
19. Remove black light and screen from beam path.
20. Remove expander lens and pulse detector.
21. Remove laser safety goggles.
22. Return laser system to service.
23. Prepare service report.

SOURCE FOR STANDARD:

Writing Team of Incumbent Workers

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 36

TASK: Troubleshoot vacuum system

STANDARD: All vacuum system leaks and vacuum pump operations not in accordance with laser system specifications must be identified.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
Laser system service manual	Spray bottle containing manufacturer's specified leak detector
Safety glasses	

PERFORMANCE GUIDE:

1. Review laser system service manual.
2. Put on safety glasses.
3. Energize laser system.
   CAUTION: DO NOT ACTIVATE HIGH VOLTAGE.
4. Determine if vacuum gauge reading is above or below laser system's recommended range.
5. Adjust gas flow to correct vacuum gauge reading.
6. Observe vacuum gauge.
   a. Proceed to step #7 if reading is in accordance with laser system specifications.
   b. Proceed as follows if gauge registers zero until problem has been identified and corrected.
      (1) Check vacuum pump for defective fuse(s).
          a. Replace defective fuse(s).
      (2) Check circuit breaker.
          a. Reset circuit breaker.
      (3) Verify operation of vacuum pump.
          a. Replace defective pump.
      (4) Check for vacuum hose leaks.
          a. Replace vacuum hose(s).
      (5) Verify operation of gas flow gauge.
          a. Replace defective gas flow gauge.
      (6) Verify operation of gas solenoid(s).
          a. Replace defective gas solenoid(s).

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 36

TASK: Troubleshoot vacuum system (Continued)

c. Proceed as follows if reading is high or other than recommended until problem has been identified and corrected.
   (1) Turn off gas flow valves.
   CAUTION: DO NOT PROCEED UNTIL SHUT-OFF VALVE IS CLOSED AND GAS BOTTLE IS SECURE.
   (2) Observe vacuum gauge.
   Note: Gauge should indicate ± zero.
   (3) Spray vacuum fittings, mirrors and valves with manufacturer's specified leak detector.
   (4) Watch for increase in pressure on gauge.
   Note: Increase indicates leak.
   (5) Repair area where increase in pressure is noted.
   (6) Clean up excess spray solution.

7. Purge vacuum system.
8. Remove safety glasses.
9. Return laser system to service.
10. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 37

TASK: Troubleshoot gas supply system

STANDARD: All gas supply system leaks must be identified. Gas supply regulators and input pressure gas flow valves must be adjusted to laser system's specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Laser system service manual
Safety glasses
Service report
Spray bottle containing manufacturer's specified leak detector

PERFORMANCE GUIDE:

1. Review laser system service manual.
2. Put on safety glasses.
3. Energize laser system.
   CAUTION: DO NOT ACTIVATE HIGH VOLTAGE.
4. Locate gas supply regulators, supply lines, and flow gauges.
5. Turn on gas bottle valve.
6. Listen for gas leaks.
   a. Repair gas leaks if necessary.
7. Test each gas control flow valve by turning it off and on.
   a. Repair or replace defective valve(s).
8. Turn off gas bottle valve.
9. Turn off gas flow valves in laser system.
10. Turn on gas bottle valve.
11. Turn off gas bottle valve.
    Note: Steps #8-11 should trap a small amount of gas.
12. Observe gas pressure gauge for pressure drop.
    a. Proceed to step #13 if pressure is maintained.
    b. Proceed as follows if pressure drops.
       (1) Repair gas leaks.
       (2) Repeat steps #8-11 if necessary.
13. Readjust all valves and flow valves to laser system specifications.
    a. Replace gas regulator if pressure does not regulate.
    b. Adjust pressure according to laser system specifications.

DUTY: ANALYZING DOWN LASER SYSTEMS

PERFORMANCE OBJECTIVE NO. 37

TASK: Troubleshoot gas supply system (Continued)

14. Remove safety glasses.
15. Return laser system to service.
16. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 38

TASK: Replace cooler fitting(s)

STANDARD: Fittings must be clean and must not leak coolant.
Fittings must not be cross threaded.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Fitting(s)	Service report
High voltage probe	Shorting bar
Laser system service manual	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to fitting(s).
8. Wipe clean all fittings and area around fitting(s) with rag.
9. Remove fitting(s).
10. Clean up coolant spillage with rag.
11. Apply teflon tape to new fitting threads.
12. Install new fitting(s).
13. Check fitting(s) for cross threading.
    a. Proceed as follows if fittings are cross threaded until problem has been corrected.
       (1) Remove fitting
       (2) Reinsert fitting
       (3) Tap fitting in place
       (4) Tighten fitting
       (5) Replace fitting if it is still cross threaded.
14. Clean up any remaining coolant.
15. Remove shorting bar.
16. Connect main power cord.
17. Energize laser system.

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 38

TASK: Replace cooler fitting(s) (Continued)

18. Check fitting(s) for leaks.
    a. Retape leaking fitting(s).
19. Adjust coolant flow to flow rate recommended in laser system specifications.
20. Remove safety glasses.
21. Return laser system to service.
22. Prepare service report.
23. Dispose of defective cooler fitting according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 39

TASK: Clean cooler fitting(s)

STANDARD: Fitting(s) must be clean and must not leak coolant.
Fitting(s) must not be cross threaded or damaged.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Can of compressed air	Service report
High voltage probe	Shorting bar
Laser system service manual	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to fitting(s).
8. Wipe clean all fittings and area around fitting(s) with clean rag.
9. Remove fitting(s).
10. Clean up coolant spillage with rag.
11. Remove old teflon tape from fitting threads.
12. Clean inside fitting(s).
13. Blow out fitting(s) with compressed air.
14. Apply teflon tape to fitting threads.
15. Reinstall fitting(s).
16. Check fitting(s) for cross threading.
    a. Proceed as follows if fittings are cross threaded until problem has been corrected.
       (1) Remove fitting.
       (2) Reinsert fitting.
       (3) Tap fitting in place.
       (4) Tighten fitting.
       (5) Replace fitting if it is still cross threaded.

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 39

TASK: Clean cooler fitting(s) (Continued)

17. Clean up any remaining coolant.
18. Remove shorting bar.
19. Connect main power.
20. Energize laser system.
21. Check fitting(s) for leaks.
    a. Tighten leaking fitting(s), or
    b. Retape leaking fitting(s).
22. Adjust coolant flow to flow rate recommended in laser system service manual.
23. Remove safety glasses.
24. Return laser system to service.
25. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 40

TASK: Recharge cooling system

STANDARD: Cooling system must have full charge of refrigeration in sight glass when in cooling cycle with no air bubbles visible in sight glass. Compressor high side pressure must be in accordance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Laser system service manual
Cooler refrigerant	Safety glasses
Manifold gauges and hoses	Service report

PERFORMANCE GUIDE:

1. Review laser system service manual.
2. Put on safety glasses.
3. Energize system cooler.
4. Locate high and low pressure valves and fittings on cooler compressor.
5. Connect blue hose from manifold gauges to low side fitting on compressor.
6. Connect red hose from manifold gauges to high side fitting on compressor.
7. Connect yellow hose from manifold gauges to refrigerant supply tank fitting.
8. Turn on refrigerant main gas valve.
9. Bleed air from refrigerant supply hoses.
10. Crack compressor low and high side valves open 1/2 turn.
11. Turn cooler control to cool cycle.
12. Locate refrigerant sight glass.
13. Open red hose pressure valve in accordance with laser system specifications.
14. Observe high side pressure gauge reading.
15. Open blue hose coolant supply valve in accordance with laser system specifications.
16. Close all valves when high pressure gauge is in accordance with laser system pressure specifications.
17. Observe coolant gas sight glass.
    Note: No air bubbles should appear.

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 40

TASK: Recharge cooling system (Continued)

18. Disconnect all gas hoses from system.
    CAUTION: DO NOT PROCEED UNTIL SHUT-OFF VALVE IS CLOSED AND GAS BOTTLE IS SECURE.
19. Readjust cooler temperature control to laser system specifications.
20. Remove safety glasses.
21. Return laser system to service.
22. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 41

TASK: Replace temperature sensor(s)

STANDARD: Thermal switch activation at laser system's specified temperature must be verified. Sensors must be securely mounted electrically and mechanically.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
Heat gun	Shorting bar
High voltage probe	Temperature sensor
Laser system service manual	Thermocouple meter
Safety glasses	VOM

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down complete laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to temperature sensors.
8. Disconnect electrical wires to sensors.
9. Disconnect temperature sensor from housing.
10. Remove sensor from system.
11. Install new sensor in housing.
12. Connect electrical wires.
13. Connect VOM across temperature sensors.
14. Hold thermocouple meter near temperature switch.
15. Turn on heat gun and direct air to temperature sensors.
16. Verify temperature sensor operation by thermocouple meter reading.
17. Remove shorting bar.
18. Connect main power.

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 41

TASK: Replace temperature sensor(s) (Continued)

19. Remove safety glasses.
20. Return laser system to service.
21. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 42

TASK: Replace defective water pump

STANDARD: Mounting bolts and electrical wiring must be secure. Water pump must not leak and must operate in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
High voltage probe	Shorting bar
Laser system service manual	Water pump
Safety glasses	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to water pump.
8. Wipe pump area with clean rag.
9. Close supply and return water valves to pump.
10. Remove electrical wires.
11. Remove input and outlet water lines.
12. Remove water pump mounting bolts.
13. Remove pump from system.
14. Install new pump in system pump mount.
15. Secure pump in place with mounting bolts.
16. Connect inlet and outlet hoses.
17. Clean up any water spillage.
18. Connect electrical wires.
19. Open supply and return water valves.
20. Remove shorting bar.
21. Connect main power.
22. Energize laser.

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 42

TASK: Replace defective water pump (Continued)

23. Test water pump for leaks and operation.
    a. Troubleshoot temperature control system if necessary.
24. Remove safety glasses.
25. Return laser system to service.
26. Prepare service report.
27. Dispose of defective water pump according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 43

TASK: Replace flow sensor

STANDARD: Mounting screws and electrical wiring must be secure. Flow sensor must not leak coolant and must operate in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Laser system service manual
Clean rags	Safety glasses
Flow sensor switch	Service report
High voltage probe	Shorting bar

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to flow sensor.
8. Shut off coolant supply and return valves.
9. Wipe area with clean rag.
10. Remove electrical wires.
11. Remove inlet and outlet coolant lines.
12. Remove flow sensor mounting screws.
13. Remove flow sensor from system.
14. Install new flow sensor in system mount.
15. Tighten mounting screws.
16. Replace inlet and outlet cooling lines.
17. Clean up spilled coolant.
18. Connect electrical wires.
19. Remove shorting bar.
20. Test flow sensor for coolant leaks and operation.
    a. Tighten mounting screws and/or electrical wires if necessary.
    b. Troubleshoot temperature control system if necessary.

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 43

TASK: Replace flow sensor (Continued)

21. Remove safety glasses.
22. Return laser system to service.
23. Prepare service report.
24. Dispose of defective flow sensor switch according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 44

TASK: Repair defective wiring

STANDARD: Continuity of wiring must be confirmed with ohmmeter. All repaired wiring must be stripped and replacement connectors must be soldered or crimped on wire ends. Wire must be continuous from terminal to terminal. Replacement wire must be same color and specification as removed wire.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
High voltage probe	Shorting bar
Ohmmeter	Solder
Replacement wire	Soldering iron
Replacement wire connectors	Wire strippers
Safety glasses	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to defective wiring.
8. Locate faulty wiring termination and start points.
9. Remove defective wire from wiring harness.
10. Cut equal length of new replacement wire of same color and gauge.
11. Strip ends of new wire.
12. Install new wire in harness.
13. Solder or crimp replacement connector(s) on wire ends.
14. Connect wire ends to start and terminate points.
15. Confirm continuity of wire using ohmmeter across wire.
16. Secure wire in wiring harness.
17. Remove shorting bar.

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 44

TASK: Repair defective wiring (Continued)

18. Connect main power.
19. Remove safety glasses.
20. Return laser system to service.
21. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 45

TASK: Replace defective hosing

STANDARD: Cooler hosing must not leak and must be secure in system in conformance with laser system specifications. All spillage must be removed.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
High voltage probe	Shorting bar
Laser system service manual	Service report
Replacement hosing	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to defective hosing.
8. Measure length of defective hosing.
9. Measure and cut new length of hosing.
10. Turn off cooler supply and return flow valves.
11. Remove defective section of hose from unit.
12. Remove hose connectors from hose ends if applicable.
13. Put hose connectors on ends of new hose.
14. Install and secure new hose in system.
15. Open supply and return cooler flow valves.
16. Clear up any cooler water spillage.
17. Remove shorting bar.
18. Connect main power.
19. Turn cooler on.

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 45

TASK: Replace defective hosing (Continued)

20. Check system for:
    a. Water leaks
    b. Water level as recommended in laser system service manual
    c. Operation according to laser system specifications
        (1) Troubleshoot temperature control system if necessary.
21. Remove safety glasses.
22. Return laser system to service.
23. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 46

TASK: Replace heat exchanger

STANDARD: All hoses and wires must be connected with temperature sensor in place. Cooler reservoir must be refilled with steam distilled or deionized water. There must be no leaks and spillage must be cleaned up.

CONDITIONS FOR PERFORMANCE OF TASK:

- Standard tool kit
- Heat exchanger
- Laser system service manual
- Safety glasses
- Service report
- Steam distilled/deionized water

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Shut down cooler pump.
4. Drain water from primary water loop.
5. Disconnect secondary input and output water lines from heat exchanger.
6. Disconnect primary input and output water hoses from top chamber of heat exchanger.
7. Disconnect temperature sensor wires from heat exchanger to connector.
8. Remove temperature sensor from heat exchanger T connector.
9. Remove mounting bolts that hold down heat exchanger.
10. Remove heat exchanger from cooler compartment.
11. Install new heat exchanger and bolt in place.
12. Install old temperature sensor onto new heat exchanger T connector.
13. Reconnect secondary input and output water hoses onto new exchanger.
14. Reconnect temperature sensor wires.
15. Reconnect primary input and output hoses to exchanger.
16. Refill cooler reservoir.
    Note: Use steam distilled water or deionized water only.
17. Energize cooler pump.
18. Check for any leaks around fittings.

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 46

TASK: Replace heat exchanger (Continued)

19. Review laser system specifications.
20. Test water temperature.
    a. Adjust if necessary
21. Remove safety glasses.
22. Return laser system to service.
23. Prepare service report.
24. Dispose of defective heat exchanger according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 47

TASK: Replace reservoir level switch

STANDARD: Cooler pump must cycle according to water level in tank. Reservoir must be refilled to water line with steam distilled deionized water.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
Reservoir level switch	Steam distilled/deionized water
Safety glasses	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down cooler pump.
3. Drain water from reservoir.
4. Disconnect molex electrical connector from level switch.
5. Remove reservoir mounting strap to gain access to retainer nut.
6. Remove level switch retainer nut.
7. Pull level switch assembly out of reservoir.
8. Install new level switch down into reservoir.
9. Tighten retainer nut.
10. Reinstall and tighten reservoir mounting strap.
11. Reconnect molex electrical connector to level switch.
12. Refill reservoir with water up to water level line.
    Note: Use deionized or steam distilled water only.
13. Turn on cooler pump.
14. Remove safety glasses.
15. Return laser system to service.
16. Prepare service report.
17. Dispose of defective reservoir level switch according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 48

TASK: Replace agitator

STANDARD: Agitator must be mechanically and electrically secure.
Agitator must agitate cooling water in cooler reservoir.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Agitator	Service report
High voltage probe	Shorting bar

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to cooler agitator and wiring.
8. Remove motor voltage supply lines.
9. Remove agitator propeller from agitator motor shaft.
10. Remove agitator mounting bolts.
11. Remove agitator from cooler unit mount.
12. Install new agitator in mount.
13. Install agitator mounting bolts.
14. Install old propeller on new agitator motor shaft.
15. Connect motor voltage supply wires.
16. Ensure that agitator propeller and shaft turn freely.
17. Remove shorting bar.
18. Connect main power
19. Turn on cooler.
    a. Troubleshoot temperature control system if necessary.
20. Verify agitator operation.
21. Remove safety glasses.
22. Return laser system to service.
23. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 49

TASK: Replace water solenoid(s)

STANDARD: Water solenoid(s) must be mechanically and electrically secure. All spilled coolant must be removed and recommended coolant level must be replenished. Solenoid must control flow of coolant in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Coolant	Service report
High voltage probe	Shorting bar
Laser system service manual	Water solenoid(s)

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Close cooler inlet and outlet flow valves.
8. Gain access to water solenoid(s).
9. Remove solenoid voltage wires.
10. Remove inlet coolant line.
11. Remove outlet coolant line.
12. Remove solenoid from mounting bracket.
13. Install new solenoid in mounting bracket.
14. Connect solenoid voltage wires.
15. Replace coolant inlet line.
16. Replace coolant outlet line.
17. Clean up spilled coolant with rag.
18. Open cooler inlet and outlet cooler flow valves.
19. Replenish any lost coolant.
20. Test solenoid(s) for coolant leaks.
21. Remove shorting bar

DUTY: REPAIRING TEMPERATURE CONTROL SYSTEM

PERFORMANCE OBJECTIVE NO. 49

TASK: Replace water solenoid(s) (Continued)

22. Remove safety glasses.
23. Return laser system to service.
24. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 50

TASK: Replace crystal rod

STANDARD: Crystal rod must be clean and secure in laser housing with no water leaks on rod faces when cooler is turned on. Laser threshold and power at establishing running current must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

- Standard tool kit
- Clean air hood
- Crystal rod
- Laser system service manual
- Methyl alcohol
- O-rings
- Retainer spanner wrench (special)
- Rod depth insertion tube
- Safety glasses
- Service report
- Surgical gloves
- VOM

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser supply.
3. Shut down cooler pump.
4. Disconnect main power.
5. Remove left and right beam tubes from rod ends.
6. Remove hex screws from pressure plates.
7. Remove left and right lamp jacket pressure plates and O-rings.
8. Set up clean air hood.
9. Tape both ends of rod jacket before removing rod assembly from laser housing.
   Note: Protect rod from dirt and water.
10. Remove crystal rod assembly from housing.
11. Place crystal rod assembly under air hood.
12. Loosen right lock nut.
13. Remove crystal from right pressure tube O-ring.
14. Wash hands.
15. Remove right side pressure tube retainer ring.
16. Replace and tighten lock nut.
17. Loosen right pressure tube set screw.
18. Loosen left side lock nut.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 50

TASK: Replace crystal rod (Continued)

19. Grasp right side pressure tube hardware with lens tissue and carefully pull out of left side pressure tube O-ring.
20. Remove crystal from jacket assembly.
    Note: Use surgical gloves or similar precautions in handling crystal rod.
21. Loosen right lock nut.
22. Remove crystal from right pressure tube O-ring.
23. Clean replacement rod body and coated ends.
    Note: Standard procedure on cleaning optical surfaces must be followed.
24. Replace right pressure tube O-ring on rod depth insertion tube.
25. Insert rod depth insertion tube into pressure tube housing.
26. Slip right lock nut on pressure tube housing.
27. Insert one end of rod into rod depth insertion tube and seat.
28. Tighten right lock nut.
    Note: O-ring should compress and water seal rod end.
29. Replace left O-ring in left pressure tube housing.
30. Loosen left pressure tube lock nut.
31. Insert crystal rod into crystal jacket and pass rod into left pressure tube housing O-ring.
32. Tighten left lock nut.
33. Loosen right lock nut and remove.
34. Remove rod depth insertion tube.
35. Replace with metal pressure tube.
36. Replace and tighten retainer ring.
37. Install left and right lock nuts and tighten.
38. Reinstall crystal jacket assembly back into laser housing.
39. Reinstall crystal jacket left and right O-rings and pressure plates.
40. Tighten plates.
41. Review laser system specifications.
42. Energize laser.
43. Check for water leaks.
44. Test power/energy output at source.
45. Remove safety glasses.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 50

TASK: Replace crystal rod (Continued)

46. Return laser system to service.
47. Prepare service report.
48. Dispose of defective crystal rod according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 51

TASK: Replace gaseous tube

STANDARD: Front and rear caps must be secure on laser housing. Wires must be connected between new gaseous tube and tube housing. Gaseous tube must discharge.

CONDITIONS FOR PERFORMANCE OF TASK:

- Standard tool kit
- Laser system service manual
- Laser tube
- O-rings
- Safety glasses
- Service report
- Shorting bar
- Silicone high vacuum grease
- Solder
- Soldering iron
- Spanner wrench

PERFORMANCE GUIDE:

Gaseous Laser Without Water Cooler Component:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Turn off gas supply valve.
   CAUTION: DO NOT PROCEED UNTIL SHUT-OFF VALVE IS CLOSED AND GAS BOTTLE IS SECURE.
5. Remove front cap from laser housing.
6. Remove rear cap from laser housing.
7. Remove laser tube mounts.
8. Slide laser tube out of housing.
9. Disconnect wires from laser tube.
10. Discard bad tube according to facility procedure.
11. Connect wires to new laser tube.
12. Solder wires.
13. Slide laser tube into housing.
14. Replace tube mounts.
15. Realign cavity if necessary.
16. Remount front cap onto laser housing.
17. Remount rear cap onto laser housing.
18. Turn on gas supply valve.
19. Energize laser.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 51

TASK: Replace gaseous tube (Continued)

20. Check laser tube operation.
    a. Troubleshoot beam generation system if laser does not perform in conformance with laser system specification.
21. Purge vacuum system.
22. Remove safety glasses.
23. Return laser system to service.
24. Prepare service report.

Gaseous Lasers With Water Cooler Component:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Shut off gas supply valve.
   CAUTION: DO NOT PROCEED UNTIL SHUT-OFF VALVE IS CLOSED AND GAS BOTTLE IS SECURE.
8. Gain access to gaseous tube.
9. Remove high voltage wires.
10. Remove front and rear mirror assembly.
11. Remove supply and return cooler lines.
12. Remove gas supply and return hoses.
13. Loosen gaseous tube and water jacket mounting brackets.
14. Remove tube from laser head.
15. Drain water from gaseous tube water jacket.
16. Remove water jacket(s) locking nuts and O-rings with spanner wrench.
17. Remove gaseous tube from water jacket.
18. Discard bad tube according to facility procedure.
19. Insert new tube in water jacket.
20. Grease O-ring.
21. Install O-ring to gaseous tube.
22. Place locking nuts on gaseous tube.
23. Tighten nuts with spanner wrench.
24. Place gaseous tube in laser head mounting brackets.
25. Realign optics cavity.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 51

TASK: Replace gaseous tube (Continued)

26. Connect vacuum inlet and outlet hoses.
27. Connect supply and return cooler lines.
28. Tighten gaseous tube mounting brackets.
29. Install front and rear mirror mounts.
30. Connect high voltage wires.
31. Realign complete beam delivery path.
32. Remove shorting bar.
33. Connect main power.
34. Energize laser.
35. Test system for water leaks.
    a. Repair leaks.
36. Test system for vacuum leaks.
    a. Troubleshoot vacuum system.
37. Purge vacuum system.
38. Check power output.
    a. Adjust power to meet laser system specifications.
39. Remove safety glasses.
40. Return laser system to service.
41. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 52

TASK: Replace mirror(s)

STANDARD: Mirror must be secure in mount with mirror peak controls locked in place. Mirrors must be aligned for optimum power and mode as specified in laser system service manual.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Mirror
Label	Mirror box
Laser safety goggles for specified wave length	Mirror holder tool
Laser system service manual	Mirror removal-retainer
Lens tissue	Operational log book
Methyl alcohol	Service report

PERFORMANCE GUIDE:

1. Shut down laser power supply.
2. Wash hands.
3. Put on laser safety goggles.
4. Remove mirror retainer ring from mirror mount.
5. Remove mirror using mirror holding tool.
6. Place old mirror in mirror box.
7. Label status of mirror in operational log book.
8. Place new mirror into holder tool.
9. Clean mirror on both sides.
10. Install new mirror into mount.
    Note: Mirror arrow should point in toward rod.
11. Replace and tighten retainer ring.
12. Realign laser cavity.
13. Energize laser.
14. Repeak mirror for optimum power according to laser system specifications.
15. Lock mirror peak controls.
16. Remove laser safety goggles.
17. Return laser system to service.
18. Prepare service report.
19. Dispose of defective mirror according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 53

TASK: Replace gold cavity

STANDARD: Block assembly must be secure in housing. Anode and cathode wires must be connected, and laser must be free of leaks. Laser threshold and power must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

- Standard tool kit
- Adjustable jack stand(s)
- Black light
- End cap pin holes
- Expander lens
- Gold cavity
- Helium neon alignment laser
- Laser safety goggles for specified wave length
- Laser system service manual
- O-rings
- Phosphor screen
- Service report

PERFORMANCE GUIDE:

1. Review laser system service manual.
2. Shut down laser power supply.
3. Wash hands.
4. Put on laser safety goggles.
5. Remove anode and cathode wires from lamp jacket assembly.
6. Remove left and right lamp jacket pressure plates.
7. Remove left and right beam tubes from crystal jacket ends.
8. Remove pressure plates and O-rings from left and right sides of crystal jacket ends.
9. Remove crystal jacket rod assembly from laser housing.
10. Remove lamp jacket assembly from laser housing.
11. Remove top cover of laser housing assembly.
12. Remove gold cavity block assembly.
13. Remove both left and right gold end plates from gold cavity block assembly.
14. Separate two halves of gold cavity block assembly.
15. Remove gold cavity.
16. Install new gold cavity into gold cavity block halves.
17. Tighten in place.
18. Install left and right end plates onto block assembly.
19. Insert entire block assembly back into laser housing.
20. Tighten block assembly.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 53

TASK: Replace gold cavity (Continued)

21. Install laser housing cover.
22. Tighten screws down evenly to prevent water leaks.
23. Replace lamp jacket assembly pressure plates.
24. Install lamp jacket assembly.
25. Install new O-rings.
26. Replace crystal jacket assembly pressure plates.
27. Install crystal jacket assembly.
28. Reposition anode and cathode wires on lamp jacket.
29. Replace left and right beam tubes in crystal rod assembly.
30. Turn laser cooler pump on.
31. Check for water leaks.
32. Realign laser.
33. Remove laser safety goggles.
34. Return laser system to service.
35. Prepare service report.
36. Dispose of defective gold cavity according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 54

TASK: Replace electrode(s)

STANDARD: Electrical and mounting screws must be secure and laser system must operate in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Electrode(s)	Service report
High voltage probe	Shorting bar
Laser system service manual	Vacuum fore pump
Oscilloscope	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to electrode(s).
8. Wipe access area with clean rag.
9. Wash hands.
10. Remove electrode electrical and mounting screw(s).
11. Pull electrode(s) from plasma tube.
    Note: Care must be taken to avoid damage to plasma tube.
12. Install new electrode(s).
13. Screw in electrical and mounting screw(s).
14. Purge vacuum system.
15. Remove shorting bar.
16. Connect main power.
17. Energize laser.
18. Test operation of laser system.
    a. Troubleshoot beam generation system if necessary.
19. Remove safety glasses.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 54

TASK: Replace electrode(s) (Continued)

20. Return laser system to service.
21. Prepare service report.
22. Dispose of defective electrode(s) according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 55

TASK: Replace polarizer

STANDARD: Polarizer must be secure and aligned with beam path. Laser output must be polarized as specified in laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Lens tissue
Adjustable jack stands	Methyl alcohol
Black light	Phosphor screen
End cap pin holes	Polarizer plates
Expander lens	Helium neon alignment laser
Laser power meter	Safety glasses
Laser system service manual	Service report

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Remove screws from top cover of polarizer.
5. Remove allen screws from Brewster block assembly.
6. Pull Brewster block assembly up out of mounting cube.
7. Loosen set screws.
8. Remove polarizer optic plates.
9. Clean both sides of new polarizer plates.
   Note: Use only metnyl alcohol and lens tissue.
10. Install new polarizer plates onto Brewster block assembly.
11. Install Brewster block into mounting cube.
12. Tighten Brewster block.
13. Replace and tighten cover.
14. Align optics.
15. Purge vacuum system.
16. Remove safety glasses.
17. Return laser system to service.
18. Prepare service report.
19. Dispose of defective polarizer according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 56

TASK: Replace Q-switch

STANDARD: Q-switch must hold off beam with continuous RF on and Q-switch in pulse position. Power output must be within laser system's specified range with bragg angle adjusted for minimum output.

CONDITIONS FOR PERFORMANCE OF TASK:

- Standard tool kit
- Adjustable jack stands
- Black light
- End cap pin holes
- Expander lens
- Helium neon alignment laser
- Laser power meter
- Laser safety goggles for specified wave length
- Laser system service manual
- Phosphor screen
- Q-switch
- Service report

PERFORMANCE GUIDE:

1. Review laser system service manual.
2. Put on laser safety goggles.
3. Shut down laser system.
   CAUTION: IF Q-SWITCH HAS EXTERNAL RF DRIVER BOX, MAKE SURE RF MODE SWITCH IS IN "OFF" POSITION.
4. Disconnect main power.
5. Remove RF cable from Q-switch assembly.
6. Remove left and right beam tubes from Q-switch assembly.
7. Remove allen screws from Q-switch base plate.
8. Lift and remove Q-switch from laser rail.
9. Place new Q-switch on rail.
10. Replace and tighten allen screws.
11. Connect RF cable to Q-switch.
12. Energize laser system.
13. Realign Q-switch to laser axis.
14. Turn on RF power to external position.
15. Measure power out with power meter.
16. Adjust bragg angle control for minimum output.
17. Switch mode to Q-switch position on driver box.
18. Replace left and right beam tubes.
19. Remove laser safety goggles.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 56

TASK: Replace Q-switch (Continued)

20. Return laser system to service.
21. Prepare service report.
22. Dispose of defective Q-switch according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

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DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 57

TASK: Repair beam expander

STANDARD: Both positive and negative lenses must be clean and free of burns. Laser output power must return to laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Methyl alcohol
Laser system service manual	Safety glasses
Lens tissue	Service report

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Loosen hand lock ring on beam expander.
4. Unscrew beam expander counterclockwise from laser front mirror mount.
5. Observe both positive and negative lenses for burns or dirt.
6. Clean lens with methyl alcohol and lens tissue.
7. Replace burnt lens if necessary.
   a. Remove negative lens retainer ring.
   b. Remove lens with tweezers.
   c. Clean and install new lens with tweezers.
      Note: Observe direction of lens curvature prior to removal of lens.
   d. Install and tighten retainer ring.
8. Repeat steps #5-7 for positive lens replacement.
9. Reinstall beam expander on front mirror mount.
10. Screw beam expander on clockwise.
11. Tighten hand lock ring.
12. Energize laser.
13. Adjust power supply to recommended running current according to laser system specifications.
14. Remove safety glasses.
15. Return laser sytem to service.
16. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 58

TASK: Replace mirror mount

STANDARD: Mirror mount must be tight and centered on laser beam axis. Peaking knobs must move freely.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Laser system service manual
Adjustable jack stands	Mirror mount
Black light	Mirror mount retainer
End cap pin holes	Phosphor screen
Expander lens	Safety glasses
Helium neon alignment laser	Service report

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Pull rear beam tube out of rear mirror mount.
4. Wash hands.
5. Remove mirror cell from old mount and transfer to new mount.
6. Remove hex screws from mirror mount laser base plate.
7. Remove old mirror mount.
8. Install new mirror mount.
9. Replace and tighten down hex screws.
10. Check that horizontal and vertical peaking knobs move freely without sticking.
11. Realign rear mirror to crystal rod axis.
12. Replace rear beam tube into rear mount.
13. Repeat steps #4-11 to replace front mirror mount.
14. Remove safety glasses.
15. Return laser system to service.
16. Prepare service report.
17. Dispose of defective mirror mount according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 59

TASK: Replace laser housing assembly

STANDARD: Laser housing must be secured to casting with no water leaks. Laser threshold and power at established current must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Adjustable jack stands
Black light
End cap pin holes
Expander lens
Helium neon alignment laser
Laser housing assembly
Laser system service manual
Phosphor screen
Safety glasses
Service report

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Remove water hose from inlet manifold.
5. Drain water from housing into reservoir.
6. Remove water hose from output manifold.
7. Disconnect lamp wires from lamp jacket assembly.
8. Remove left and right beam tubes from crystal jacket ends.
9. Remove tie-down screws from housing brackets to laser casting.
10. Lift out entire laser housing assembly from laser casting.
11. Remove top housing cover.
12. Transfer laser components to new laser housing assembly:
    a. Inlet manifold and O-ring
    b. Output manifold and O-ring
    c. Top cover O-ring
    d. Gold cavity block assembly
    e. Lamp sleeves
    f. Lamp jacket assembly and pressure plates
       CAUTION: OBSERVE POLARITY OF LAMP WHEN INSERTING IN NEW HOUSING.
    g. Crystal jacket assembly and pressure plates
    h. Top cover
    i. Left and right housing tie-down brackets.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 59

TASK: Replace laser housing assembly (Continued)

13. Reinstall entire housing assembly back onto laser casting.
14. Tighten housing assembly.
15. Attach input-output hoses to manifolds.
16. Tighten hoses.
17. Connect lamp wires to lamp jacket ends.
18. Turn on cooler.
19. Check for water leaks and correct if necessary.
20. Review laser system specifications.
21. Energize laser.
22. Check for lamp ignition.
23. Realign laser.
24. Remove safety glasses.
25. Return laser system to service.
26. Prepare service report.
27. Dispose of defective housing assembly according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 60

TASK: Replace flash lamp

STANDARD: Flash lamp must ignite and remain lit. Lamp glass must be clean and lamp retainer must be free of leaks. Laser threshold and power at established running current must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Lens tissue
Flash lamp	Methyl alcohol
High voltage probe	Safety glasses
Lamp extraction tool	Service report
Lamp retainer spanner wrench	Shorting bar
Lamp seating tool	VOM
Laser system service manual	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Insert shorting bar.
4. Attach high voltage probe.
5. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
6. Shut down power to cooler.
7. Remove lamp power electrode from lamp jacket.
8. Remove lamp retainer from lamp jacket end.
9. Extract lamp from lamp jacket.
10. Clean glass area of new lamp.
11. Insert lamp into lamp jacket, matching polarization of lamp and lamp jacket.
12. Seat lamp securely into electrode lamp socket.
13. Reinstall lamp retainer.
    Note: Tighten securely to prevent water leaks.
14. Reinstall power electrode in lamp socket end.
    CAUTION: HIGH VOLTAGE PRESENT.
15. Tighten securely to prevent arcing.
16. Turn cooler pump on.
17. Check for leaks.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 60

TASK: Replace flash lamp (Continued)

18. Review laser system service manual.
19. Remove shorting bar.
20. Energize laser.
21. Check that lamp ignites and remains lit.
22. Remove safety glasses.
23. Return laser system to service.
24. Prepare service report.
25. Dispose of defective lamp jacket according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 61

TASK: Replace lamp jacket

STANDARD: Flash lamp must light and remain lit. Lamp glass must be clean and lamp retainer must be free of leaks. Laser threshold and power at established running current must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
High voltage probe
Lamp extraction tool
Lamp jacket
Lamp retainer spanner wrench
Lamp seating tool
Laser system service manual
Lens tissue
Methyl alcohol
O-rings
Safety glasses
Service report
Shorting bar

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Insert shorting bar.
4. Attach high voltage probe.
5. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
6. Shut down power to cooler.
7. Remove lamp power electrode from lamp socket.
8. Remove flash lamp from lamp jacket.
9. Remove hex screws from left pressure plates.
10. Remove outer pressure plate.
11. Remove thin O-ring.
12. Remove inner pressure plate.
13. Remove thick O-ring from lamp jacket end.
14. Repeat steps #9-13 for right side pressure plates.
15. Pull lamp jacket completely out of laser housing.
16. Insert new lamp jacket into laser housing.
17. Replace thick O-ring.
18. Place thick O-ring back over left side of lamp jacket.
19. Install inner pressure plate back over lamp jacket.
20. Replace thin O-ring.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 61

TASK: Replace lamp jacket (Continued)

21. Place thin O-ring over jacket end.
22. Install outer pressure plate back over lamp jacket.
23. Install hex screws through both pressure plates and tighten using lock washer and flat blade on each screw.
24. Repeat steps #17-23 for right side of jacket.
25. Clean lamp glass prior to insertion.
26. Insert lamp into jacket matching polarization of lamp and lamp jacket.
27. Seat lamp securely into electrode lamp socket.
28. Reinstall lamp retainer securely.
29. Reinstall power electrode in lamp socket end.
    CAUTION: POWER ELECTRODE MUST BE FIRM TO PREVENT ARCING.
30. Turn cooler pump on.
31. Check for water leaks.
32. Review laser system specifications.
33. Remove shorting bar.
34. Energize laser.
35. Check that lamp ignites and remains lit.
36. Remove safety glasses.
37. Return laser system to service.
38. Prepare service report.
39. Dispose of defective lamp.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 62

TASK: Collimate beam expander

STANDARD: Diameter of beam must be equal when compared at 8 feet and at 4 inches.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Laser system service manual
Black light	Phosphor screen
Laser safety goggles for specified wave length	Service report

PERFORMANCE GUIDE:

1. Energize laser to recommended operating current as per laser system service manual.
2. Put on laser safety goggles.
3. Close laser shutter internally.
4. Place phosphor screen 4 inches from beam expander output.
5. Turn on black light to illuminate screen.
6. Open internal shutter.
7. Note diameter of beam on screen.
8. Move screen and black light out to a distance of 8 feet.
9. Note diameter of beam on screen.
10. Compare diameter of beam at 8 feet and at 4 inches.
    a. Proceed as follows if diameter of beam is larger at 8 feet than at 4 inches.
        (1) Loosen lock ring on positive lens.
        (2) Rotate lens clockwise one turn or more.
        (3) Recheck beam diameter at 8 feet and at 4 inches.
        (4) Repeat steps # (2) and (3) until diameter is equal at both distances.
        (5) Tighten lock ring when diameter is equal.
    b. Proceed as follows if diameter of beam is smaller at 8 feet than at 4 inches:
        (1) Loosen lock nut on positive lens.
        (2) Rotate lens counter clockwise one turn or more.
        (3) Recheck beam diameter at 8 feet and at 4 inches.
        (4) Repeat steps #b.(2) and b.(3) until diameter is equal at both distances.
        (5) Tighten lock ring when diameter is equal.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 62

TASK: Collimate beam expander (Continued)

11. Close internal shutter.
12. Remove laser safety goggles.
13. Return laser system to service.
14. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 63

TASK: Verify peak pulse power

STANDARD: Calculated peak pulse power must be in conformance with peak pulse power recommended in laser system service manual.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Laser system service manual
Frequency counter	Operational log book
Laser power meter	Oscilloscope
Laser safety goggles for specified wave length	Pulse detector
	Service report

PERFORMANCE GUIDE:

1. Energize laser system.
2. Adjust running current to recommended current specified in laser system service manual.
3. Put on laser safety goggles.
4. Attach laser power meter.
5. Check that laser is Q-switching.
6. Measure power out of front mirror.
7. Record reading in operational log book.
8. Install laser pulse detector on rear mirror mount.
9. Attach oscilloscope.
10. Record pulse width reading from oscilloscope in operational log book.
11. Connect frequency counter into sync out connection on back of RF driver.
12. Record counter reading in operational log book.
13. Multiply pulse width reading times frequency reading.
14. Divide result into power reading.
15. Compare calculation with peak power pulse specified in laser system specifications.
    Note: Calculation and specified peak power pulse must be equal.
16. Shut down laser.
17. Remove laser safety goggles.
18. Return laser system to service.
19. Prepare service report.

SOURCE FOR STANDARD:

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 64

TASK: Verify frequency of pulse train

STANDARD: Deviation between frequency counter reading and dial setting on RF must be within laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Oscilloscope
Frequency counter	Pulse detector
Laser system service manual	Safety glasses
Operational log book	Service report

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Energize laser system.
3. Operate laser at running current specified in laser system service manual.
4. Install pulse detector in beam path for front mirror mount.
5. Connect cable from pulse detector output to oscilloscope input.
6. Check that laser is Q-switching and pulse chain appears on scope screen.
7. Set RF driver control dial to desired repetition rate.
   Note: Setting range 100 hertz to 80 kilohertz.
8. Observe oscilloscope to verify pulse chain is stable.
9. Connect frequency counter input to RF driver sync output, with BNC cable.
10. Turn on counter
11. Record reading from counter in operational log book.
12. Record reading on dial setting in operational log book.
13. Compare readings.
    a. Proceed to step #14 if readings are in conformance with laser system specifications.
    b. Troubleshoot RF system if readings do not conform to laser system specifications.
14. Install pulse detector on rear mirror mount.
15. Repeat steps #5-13 for rear mirror mount verification of frequency of pulse train.

DUTY: REPAIRING BEAM GENERATION SYSTEM

PERFORMANCE OBJECTIVE NO. 64

TASK: Verify frequency of pulse train (Continued)

16. Remove safety glasses.
17. Return laser system to service.
18. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 65

TASK: Replace high voltage capacitors

STANDARD: High voltage capacitors must be securely connected and must be installed according to laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
High voltage capacitors	Service report
High voltage probe	Shorting bar
Laser system service manual	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Remove high voltage power supply from extrusion.
8. Remove defective capacitor from circuit.
9. Insert replacement high voltage capacitor(s) in circuit according to laser system service manual.
10. Secure high voltage capacitor in circuit.
11. Return high voltage power supply to extrusion.
12. Remove shorting bar.
13. Connect main power.
14. Energize laser.
15. Listen for arcing. Proceed as follows until problem has been corrected if laser is arcing:
    a. Ensure that all cables are away from grounding surfaces.
    b. Check potting compound for breakdown or degradation.
       (1) Repair if necessary.
    c. Troubleshoot excitation system if necessary.

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 65

TASK: Replace high voltage capacitors (Continued)

16. Remove safety glasses.
17. Return laser system to service.
18. Prepare service report.
19. Dispose of defective capacitor(s) according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 66

TASK: Replace high voltage diodes

STANDARD: Soldered joint must be shiny and smooth. Diodes must be installed with negative and positive polarity in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Shorting bar
High voltage probe	Solder
Laser system service manual	Soldering iron
Needle nose pliers	Solder puller
Safety glasses	Wire cutters
Service report	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Remove excitation circuit from extrusion.
8. Heat solder joints of diode(s) with soldering iron.
9. Remove solder from solder joint with solder puller.
10. Remove defective diode(s).
    Note: Observe polarity of diode prior to removal.
11. Place new diode in board observing polarity of previous diode.
12. Heat solder joint(s) with soldering iron.
13. Solder joint until soldered joint is shiny and smooth.
14. Cut excess diode leads close to soldered joint.
15. Return excitation circuit to extrusion.
16. Remove shorting bar.
17. Connect main power.
18. Energize laser.
19. Review laser system service manual.

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 66

TASK: Replace high voltage diodes (Continued)

20. Measure high voltage power output.
    a. Adjust voltage to meet laser system specifications.
21. Remove safety glasses.
22. Return laser system to service.
23. Prepare service report.
24. Dispose of defective high voltage diode(s) according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 67

TASK: Replace SCR (silicon control rectifier)

STANDARD: SCR must be secure. Soldered joints must be smooth and shiny. Polarity must be consistent with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
Heat sink compound	Shorting bar
High voltage probe	Solder
Laser system service manual	Soldering iron
Safety glasses	VOM

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Remove laser supply bottom cover.
8. Loosen and remove nut from cathode of SCR.
9. Remove wire lug from cathode stud.
10. Unsolder and remove anode wire from SCR.
11. Unsolder and remove gate wire from SCR.
12. Remove SCR from mounting bracket.
13. Check that mica insulator is not damaged on bracket.
    a. Replace damaged insulation if necessary.
14. Apply heat sink compound to new SCR cathode mounting base.
15. Install new SCR into mounting bracket.
16. Install and tighten nut on SCR.
17. Attach VOM.
18. Test to ensure that SCR cathode is electrically isolated from chassis bracket.
19. Solder anode wire back on new SCR.
20. Solder gate wire back on new SCR.
21. Repeat steps #8-20 to replace other defective SCRs.

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 67

TASK: Replace SCR (silicon control rectifier) (Continued)

22. Replace laser supply bottom cover.
23. Remove shorting bar.
24. Connect main power.
25. Energize laser.
26. Remove safety glasses.
27. Review laser system specifications.
28. Return laser system to service.
29. Prepare service report.
30. Dispose of defective SCR according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 68

TASK: Replace defective board(s)

STANDARD: Input and output connectors must be securely connected and all mounting screws must be tightened to chassis.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
Board(s)	Shorting bar
High voltage probe	VOM
Safety glasses	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Remove bottom laser supply cover.
8. Disconnect input connector from board.
9. Disconnect output connector from board.
10. Remove mounting screws from board.
11. Remove defective board.
12. Install new board.
13. Install mounting screws into new board.
14. Tighten screws to chassis.
15. Connect input connector.
16. Connect output connector.
17. Replace bottom laser supply cover.
18. Remove shorting bar.
19. Connect power cable.
20. Energize laser.
21. Remove safety glasses.
22. Return laser system to service.
23. Prepare service report.
24. Dispose of defective board(s) according to facility procedure.

SOURCE FOR STANDARD:

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 69

TASK: Repair defective board(s)

STANDARD: Board(s) must operate in conformance with specifications. All soldered joints must be smooth and shiny.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
High voltage probe	Shorting bar
Laser system service manual	Solder
Oscilloscope	Soldering iron
Safety glasses	Wire

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Remove defective board(s) from extrusion.
8. Inspect boards for cracks or broken or lifted trace(s).
   a. Remove loose trace(s).
   b. Solder wire to bridge broken board(s).
   c. Replace cracked or broken board(s).
9. Return board to extrusion.
10. Remove shorting bar.
11. Connect main power.
12. Energize laser.
13. Verify board operation.
    a. Troubleshoot excitation system if power supply does not operate in conformance with laser system specifications.
14. Remove safety glasses.
15. Return laser system to service.
16. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 70

TASK: Replace high voltage cable(s)

STANDARD: Cable(s) must be securely connected and tube mounts must be tight. Laser system must operate without arcing, at recommended running current as specified in laser system service manual.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
High voltage cable	Service report
High voltage probe	Shorting bar
Laser system service manual	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Disconnect high voltage cable from high voltage power supply.
8. Remove rear end cap on laser tube housing.
9. Remove front cap on laser tube housing.
10. Loosen tube mounts.
11. Slide tube out of housing.
12. Disconnect high voltage cable(s) from tube.
13. Connect replacement high voltage cable to laser tube.
14. Slide tube back into housing.
15. Tighten tube mounts.
16. Remount front cap on laser tube housing.
17. Remount rear cap on laser tube housing.
18. Connect high voltage cable to high voltage power supply.
19. Remove shorting bar.
20. Connect main power.
21. Energize laser.
22. Review laser system service manual.

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 70

TASK: Replace high voltage cable(s) (Continued)

23. Listen for arcing. Proceed as follows if arcing is present.
    a. Ensure that all cables are away from grounding surfaces.
    b. Check potting compound for breakdown or degradation.
        (1) Repair if necessary.
    c. Troubleshoot excitation system.
24. Remove safety glasses.
25. Return laser system to service.
26. Prepare service report.
27. Dispose of defective cable according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 71

TASK: Replace defective resistor(s)

STANDARD: Replacement resistor must be soldered in place using resistor with values as specified in laser system service manual. All soldered joints must be smooth and shiny.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Shorting bar
High voltage probe	Solder
Laser system service manual	Soldering iron
Resistors	Solder puller
Safety glasses	VOM
Service report	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Remove high voltage power supply from extrusion.
8. Heat soldered joints of defective resistor.
9. Remove solder.
10. Remove defective resistor from circuit.
11. Install replacement resistor in circuit using laser system specifications for resistor value.
12. Solder resistor in circuit.
13. Return high voltage power supply to extrusion.
14. Remove shorting bar.
15. Connect main power.
16. Energize laser.
17. Measure high voltage output.
    a. Adjust voltage to meet laser system specifications.
18. Remove safety glasses.

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 71

TASK: Replace defective resistor(s) (Continued)

19. Return laser system to service.
20. Prepare service report.
21. Dispose of defective resistor(s) according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 72

TASK: Replace defective fuse(s)

STANDARD: Defective fuse must be replaced with fuse of current and voltage rating specified in laser system specifications. Power supply must operate in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Fuse pullers	Service report
Fuses	Shorting bar
High voltage probe	VOM
Laser system service manual	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Remove power supply from extrusion.
8. Remove defective fuse from fuse holder.
9. Review laser system specifications.
10. Install new fuse in fuse holder with voltage and current rating in accordance with laser system specifications.
11. Return power supply to extrusion.
12. Remove shorting bar.
13. Connect main power.
14. Energize laser.
15. Check power supply operation. Proceed as follows if power supply does not operate in accordance with laser system specifications.
    a. Verify that fuse replacement meets laser system specifications.
    b. Check boards supplied by low voltage power supply for shorts.
    c. Troubleshoot low voltage power supply.

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 72

TASK: Replace defective fuse(s) (Continued)

16. Remove safety glasses.
17. Return laser system to service.
18. Prepare service report.
19. Dispose of defective fuse(s) according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 73

TASK: Replace three-phase contactor

STANDARD: Contactor must be secure in mount. All hook up wires must be mechanically and electrically mounted. Wiring must not be frayed.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Contactor	Service report
High voltage probe	Shorting bar
Laser system service manual	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down complete laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to contactor.
8. Remove contactor solenoid energizer wires.
9. Remove contactor phase power wires.
10. Remove contactor mounting screws.
11. Remove contactor from system.
12. Install new contactor.
13. Connect phase power lines.
14. Connect solenoid energizer wires.
15. Remove shorting bar.
16. Connect main power.
17. Energize system.
18. Test high voltage power supply.
    a. Adjust voltage to conform with recommended range in laser system service manual.
19. Remove safety glasses.

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 73

TASK: Replace three-phase contactor (Continued)

20. Return laser system to service.
21. Prepare service report.
22. Dispose of defective contactor according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 74

TASK: Replace high voltage dump contactor

STANDARD: High voltage dump contactor wires must be soldered in place and ground wire must be connected. All soldered joints must be smooth and shiny. Contactor must discharge high voltage power supply when de-activated.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Shorting bar
High voltage contactor	Solder
High voltage probe	Soldering iron
Safety glasses	Solder puller
Service report	VOM

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down complete laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to high voltage dump contactor.
8. Unsolder and remove high voltage wire from contactor.
9. Unsolder and remove two low voltage solenoid wires.
10. Disconnect ground wire.
11. Remove dump contactor from bracket.
12. Place new dump contactor in bracket and screw into place.
13. Solder high voltage wire on to contactor.
14. Solder two low voltage wires to contactor solenoid.
15. Connect ground wires.
16. Remove shorting bar.
17. Connect main power.
18. Energize laser.
19. Check operation of contactor.
    a. Troubleshoot excitation system if necessary.

DUTY: REPAIRING EXCITATION SYSTEM

PERFORMANCE OBJECTIVE NO. 74

TASK: Replace high voltage dump contactor (Continued)

20. Remove safety glasses.
21. Return laser system to service.
22. Prepare service report.
23. Dispose of defective high voltage dump contactor according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING LOW VOLTAGE POWER SUPPLY

PERFORMANCE OBJECTIVE NO. 75

TASK: Replace capacitor(s)

STANDARD: Capacitor must be soldered in circuit and installed according to laser system service manual. Soldered joints must be smooth and shiny.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Shorting bar
Capacitor(s)	Solder
High voltage probe	Solder puller
Laser system service manual	VOM
Safety glasses	Wire cutters
Service report	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Remove high voltage power supply from extrusion.
8. Heat soldered joints of defective capacitor.
9. Remove solder.
10. Remove defective capacitor from circuit.
11. Install replacement capacitor in circuit according to laser system specifications.
12. Solder capacitor in circuit.
13. Return power supply to extrusion.
14. Remove shorting bar.
15. Connect main power.
16. Energize laser.
17. Check low voltage power supply operation.
    a. Troubleshoot low voltage power supply if necessary.
18. Remove safety glasses.

DUTY: REPAIRING LOW VOLTAGE POWER SUPPLY

PERFORMANCE OBJECTIVE NO. 75

TASK: Replace capacitor(s) (Continued)

19. Return laser system to service.
20. Prepare service report.
21. Dispose of defective capacitor(s) according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING LOW VOLTAGE POWER SUPPLY

PERFORMANCE OBJECTIVE NO. 76

TASK: Replace diode(s)

STANDARD: Diodes must be in place and must be soldered smooth and shiny. Low voltage power supply wires must be connected. Polarity must be in conformance with laser system service manual specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Shorting bar
Diode(s)	Solder
High voltage probe	Soldering iron
Laser system service manual	Solder puller
Safety glasses	VOM
Service report	

PERFORMANCE GUIDE:

1. Review laser system service manual.
2. Put on safety glasses.
3. Shut down laser power supply.
4. Disconnect main power.
5. Insert shorting bar.
6. Attach laser power meter.
7. Measure voltage remaining in system
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
8. Disconnect wires from low voltage power supply.
9. Remove power supply from extrusion.
10. Heat soldered joints.
11. Remove solder.
12. Remove defective diode.
13. Install replacement diode in circuit according to laser system specifications.
14. Solder diode in circuit.
15. Return power supply to extrusion.
16. Remove shorting bar.
17. Reconnect low voltage power supply wires.
18. Check low voltage power supply operation.
    a. Tighten wire connections, or
    b. Adjust power input until it is in conformance with laser system specifications.

DUTY: REPAIRING LOW VOLTAGE POWER SUPPLY

PERFORMANCE OBJECTIVE NO. 76

TASK: Replace diode(s) (Continued)

19. Remove safety glasses.
20. Return laser system to service.
21. Prepare service report.
22. Dispose of defective diode(s) according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING LOW VOLTAGE POWER SUPPLY

PERFORMANCE OBJECTIVE NO. 77

TASK: Replace low voltage power supply

STANDARD: Input wires must be connected to transformer and output wires must be connected to low voltage power supply. Power must be adjusted to voltage recommended in laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
High voltage probe	Service record
Laser system service manual	Shorting bar
Low voltage power supply	VOM

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Disconnect wires from low voltage power supply.
8. Remove defective power supply from system.
9. Connect input wires (AC) to transformer.
10. Reconnect output wires (DC) to low voltage power supply.
11. Remove shorting bar.
12. Connect main power.
13. Energize laser.
14. Review laser system service manual.
15. Attach VOM.
16. Measure output of low voltage power supply.
    a. Adjust voltage up or down until it is in conformance with laser system specifications.
17. Remove VOM.
18. Remove safety glasses.

DUTY: REPAIRING LOW VOLTAGE POWER SUPPLY

PERFORMANCE OBJECTIVE NO. 77

TASK: Replace low voltage power supply (Continued)

19. Return laser system to service.
20. Prepare service report.
21. Dispose of defective low voltage power supply according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING LOW VOLTAGE POWER SUPPLY

PERFORMANCE OBJECTIVE NO. 78

TASK: Replace transformer

STANDARD: Transformer must be soldered smooth and shiny in circuit with secondary and primary wiring in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Solder
High voltage probe	Soldering iron
Laser system service manual	Solder puller
Safety glasses	Transformer
Service report	VOM
Shorting bar	Wire

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Remove power supply cover.
8. Remove power supply.
9. Heat solder joints on defective transformer.
10. Remove solder.
11. Wire transformer, secondary and primary according to laser system specifications.
12. Place transformer in power supply circuit.
13. Solder transformer in circuit.
14. Return power supply to extrusion.
15. Replace and secure power supply cover.
16. Remove shorting bar.
17. Check low voltage power supply operation.
    a. Troubleshoot low voltage supply if operation is not in conformance with laser system specifications.

DUTY: REPAIRING LOW VOLTAGE POWER SUPPLY

PERFORMANCE OBJECTIVE NO. 78

TASK: Replace transformer (Continued)

18. Remove safety glasses.
19. Return laser system to service.
20. Prepare service report.
21. Dispose of defective transformer according to facility procedure

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING RF SYSTEM

PERFORMANCE OBJECTIVE NO. 79

TASK: Replace RF cable connector(s)

STANDARD: Center pin must be soldered smooth and shiny to cable end and center pin must be seated into RF connector. Cable connector(s) must be attached according to laser system service manual specifications. All cable shields must be braided according to manufacturer's instructions. Cable must be attached between RF driver and Q-switch without arcing or shorting.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	RF cable connector
Crimp tool	Safety glasses
High voltage probe	Service report
Laser system service manual	Shorting bar
Manufacturer's instructions for RF cable connector	Solder
	Soldering iron
Ohmmeter	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down RF driver.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Remove RF cable from driver to Q-switch.
8. Cut defective connector off of RF cable.
9. Attach replacement cable connector according to laser system service manual.
10. Braid cable shields according to manufacturer's instructions.
11. Attach ohmmeter.
12. Check between center pin and outer shield for any possible short.
    a. Repeat steps #7-10 if cable is shorted.

DUTY: REPAIRING RF SYSTEM

PERFORMANCE OBJECTIVE NO. 79

TASK: Replace RF cable connector(s) (Continued)

13. Connect cable back between RF driver and Q-switch.
14. Remove shorting bar.
15. Connect RF driver power.
16. Remove safety glasses.
17. Return laser system to service.
18. Prepare service report.
19. Dispose of defective RF cable connector according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING RF SYSTEM

PERFORMANCE OBJECTIVE NO. 80

TASK: Replace RF driver

STANDARD: Controller box, RF output and low voltage supply must all be connected to RF driver. Heat sink compound must be smoothly and evenly distributed across back of RF driver box.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
Heat sink compound	Shorting bar
High voltage probe	VOM
Safety glasses	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down RF driver.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Remove connector from RF driver to controller box.
8. Remove RF output connector.
9. Remove power connector from low voltage supply to RF driver.
10. Remove mounting screws from bulkhead wall to RF driver box.
11. Remove RF driver box.
12. Apply heat sink compound to back of replacement RF driver box.
    Note: Spread compound evenly across surface.
13. Mount replacement driver onto bulkhead wall with mounting screws.
14. Tighten down replacement driver.
15. Reconnect controller box connector to RF driver.
16. Reconnect RF output connector.
17. Reconnect RF low voltage power supply connector to RF driver.
18. Remove shorting bar.

DUTY: REPAIRING RF SYSTEM

PERFORMANCE OBJECTIVE NO. 80

TASK: Replace RF driver (Continued)

19. Turn RF power back on.
20. Remove safety glasses.
21. Return laser system to service.
22. Prepare service report.
23. Dispose of defective RF driver according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING VACUUM SYSTEM

PERFORMANCE OBJECTIVE NO. 81

TASK: Replace vacuum pump

STANDARD: Mounting bolts, vacuum input hose, power cable, and exhaust line must be secure in system. Oil level and operation of vacuum pump must be in conformance with laser system specifications.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
High voltage probe	Shorting bar
Laser system service manual	Vacuum pump
Oil	VOM
Safety glasses	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to vacuum pump.
8. Wipe area clean with rag.
9. Disconnect pump input hose.
10. Label cable wires before disconnecting to maintain phase relationships.
11. Disconnect pump power cable.
12. Disconnect pump exhaust line.
13. Remove pump mounting bolts.
14. Remove pump from system.
15. Check new pump for oil level.
    a. Add oil to level recommended in laser system service manual.
16. Place new pump in laser system.

DUTY: REPAIRING VACUUM SYSTEM

PERFORMANCE OBJECTIVE NO. 81

TASK: Replace vacuum pump (Continued)

17. Reinstall mounting bolts.
18. Tighten bolts.
19. Connect vacuum input hose.
20. Connect power cable according to labeling on wires.
21. Connect exhaust line.
22. Remove shorting bar.
23. Connect main power.
24. Energize laser.
25. Test laser vacuum system.
    a. Troubleshoot vacuum system if necessary.
26. Purge vacuum system.
27. Remove safety glasses.
28. Return laser system to service.
29. Prepare service report.
30. Dispose of defective vacuum pump according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING VACUUM SYSTEM

PERFORMANCE OBJECTIVE NO. 82

TASK: Replace vacuum hose(s)

STANDARD: Vacuum hose end(s) must be cleanly cut and hose clamp(s) must be secure on fitting(s). Vacuum grease must be applied evenly and without caking. Vacuum system must be purged and must not leak.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Shorting bar
High voltage probe	Tape measure
Oscilloscope	Vacuum hose
Safety glasses	Vacuum grease
Service report	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to defective vacuum hose(s).
8. Remove hose and clamps.
9. Measure and cut new lengths of hose.
10. Pull hose clamps off old hose.
11. Put new clamps on hose.
12. Insert new hose back in system.
13. Apply thin coat of vacuum grease on end of each fitting.
14. Push hose back on fittings.
15. Tighten hose clamps.
16. Remove shorting bar.
17. Connect main power.
18. Energize laser.

DUTY: REPAIRING VACUUM SYSTEM

PERFORMANCE OBJECTIVE NO. 82

TASK: Replace vacuum hose(s) (Continued)

19. Check vacuum system for leaks.
    a. Tighten hose clamps if necessary.
20. Purge vacuum system.
21. Remove safety glasses.
22. Return laser system to service.
23. Prepare service report.
24. Dispose of defective vacuum hose(s) according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING VACUUM SYSTEM

PERFORMANCE OBJECTIVE NO. 83

TASK: Purge vacuum system

STANDARD: Vacuum system must be free of contaminated gas and must be filled with gas specified in laser system service manual.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit
Laser system service manual
Safety glasses
Service report

PERFORMANCE GUIDE:

1. Review laser system service manual.
2. Put on safety glasses.
3. Energize laser system.
   CAUTION: DO NOT ACTIVATE HIGH VOLTAGE.
4. Turn off all gas supply valves.
   CAUTION: DO NOT PROCEED UNTIL SHUT-OFF VALVE IS CLOSED AND GAS BOTTLE IS SECURE.
5. Turn on vacuum pump.
6. Run vacuum pump until pressure is stabilized and within laser system specifications for evacuated system.
   a. Troubleshoot vacuum system if specified pressure cannot be achieved.
7. Fill laser to pressure and composition specified in laser system service manual.
8. Remove safety glasses.
9. Return laser system to service.
10. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING VACUUM SYSTEM

PERFORMANCE OBJECTIVE NO. 84

TASK: Change vacuum pump oil

STANDARD: Vacuum pump must be replenished to sight glass with oil weight recommended in laser system specifications. Drain oil plug must be replaced and all spilled oil must be removed.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
High voltage probe	Service report
Laser system service manual	Shorting bar
Oil pan	Vacuum pump oil

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Energize laser.
3. Run laser for 10 minutes.
   Note: Laser system components must be warm.
4. Shut down laser system.
5. Disconnect main power.
6. Insert shorting bar.
7. Attach high voltage probe.
8. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
9. Gain access to vacuum pump.
10. Wipe vacuum pump clean with rag.
11. Remove vacuum pump oil fill cap.
12. Place oil pan under vacuum pump.
13. Remove drain oil plug.
14. Drain oil into oil pan.
15. Replace drain oil plug.
16. Fill pump with new oil up to sight glass.
17. Replace oil fill cap.
18. Clean up any spilled oil.
19. Remove shorting bar.

DUTY: REPAIRING VACUUM SYSTEM

PERFORMANCE OBJECTIVE NO. 84

TASK: Change vacuum pump oil (Continued)

20. Connect main power.
21. Remove safety glasses.
22. Return laser system to service.
23. Prepare service report.
24. Dispose of drained oil according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING GAS SUPPLY SYSTEM

PERFORMANCE OBJECTIVE NO. 85

TASK: Replace gas flow gauge(s)

STANDARD: Gas flow gauge(s) must be secure in mount and must not leak gas.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Service report
Flow gauge(s)	Shorting bar
High voltage probe	Spray bottle containing manufacturer's specified leak detector
Laser system service manual	
Safety glasses	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser power supply.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Turn off main gas supply valve.
   CAUTION: DO NOT PROCEED UNTIL SHUT-OFF VALVE IS CLOSED AND GAS BOTTLE IS SECURE.
8. Gain access to gas flow gauge(s).
9. Wipe area clean with rag.
10. Remove inlet and outlet gas lines.
11. Remove gauge(s) from system.
12. Wash hands.
13. Connect new gauge(s) in system mount.
14. Connect gas inlet and outlet lines.
    Note: Be careful not to cross thread fitting(s).
15. Turn on gas supply valve.
16. Remove shorting bar.
17. Energize laser.

DUTY: REPAIRING GAS SUPPLY SYSTEM

PERFORMANCE OBJECTIVE NO. 85

TASK: Replace gas flow gauge(s) (Continued)

18. Test flow gauge(s) for gas leaks and operation.
19. Remove safety glasses.
20. Return laser system to service.
21. Prepare service report.
22. Dispose of defective gas flow gauge according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING GAS SUPPLY SYSTEM

PERFORMANCE OBJECTIVE NO. 86

TASK: Replace gas solenoid(s)

STANDARD: Gas solenoid(s) must be secure in mount. Hook up wires must be mechanically and electrically secure. Solenoid must not leak gas.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Gas solenoid(s)	Service report
High voltage probe	Shorting bar
Laser system service manual	Teflon tape
Leak test liquid	VOM

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down complete laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Turn off main gas supply valve.
   CAUTION: DO NOT PROCEED UNTIL SHUT-OFF VALVE IS CLOSED AND GAS BOTTLE IS SECURE.
8. Gain access to gas solenoid(s).
9. Clean area with rag.
10. Remove solenoid electrical wires.
11. Remove inlet and outlet gas supply lines.
12. Remove gas solenoid from system.
13. Wash hands.
14. Install new gas solenoid in mounting bracket.
15. Connect gas inlet and outlet lines.
    Note: Be careful not to cross thread fittings.
16. Wrap fitting threads with teflon tape.
17. Connect electrical wires to solenoid.
18. Turn on gas supply valve.
19. Remove shorting bar.

DUTY: REPAIRING GAS SUPPLY SYSTEM

PERFORMANCE OBJECTIVE NO. 86

TASK: Replace gas solenoid(s) (Continued)

20. Energize laser.
21. Test gas solenoid for gas leaks and operation.
    a. Troubleshoot gas supply system if necessary.
22. Remove safety glasses.
23. Return laser system to service.
24. Prepare service report.
25. Dispose of defective gas solenoid according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING GAS SUPPLY SYSTEM

PERFORMANCE OBJECTIVE NO. 87

TASK: Repair gas leak(s)

STANDARD: Laser system must pass manufacturer's gas leak test. All fittings and clamps must be tight and O-rings must be replaced. Punctured hosing must be repaired or replaced.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
High voltage probe	Service report
Hosing	Silicone vacuum greaser
Laser system service manual	Shorting bar
Leak test liquid	VOM
O-rings	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to gas leak area.
8. Identify gas leak source.
   a. Hose clamp
   b. O-ring fitting(s) in coupling
   c. Metal fitting(s)
   d. Gas hose puncture.
9. Tighten leaking hose clamps.
10. Replace O-rings.
11. Tighten metal fittings.
12. Repair or replace punctured gas hosing.
13. Remove shorting bar.
14. Connect main power.

DUTY: REPAIRING GAS SUPPLY SYSTEM

PERFORMANCE OBJECTIVE NO. 87

TASK: Repair gas leak(s) (Continued)

15. Energize laser.
16. Test system for gas leaks according to laser system service manual.
    a. Repair gas leak(s) if necessary.
17. Remove safety glasses.
18. Return laser system to service.
19. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING GAS SUPPLY SYSTEM

PERFORMANCE OBJECTIVE NO. 88

TASK: Replace gas regulator(s)

STANDARD: Gas fitting must not be leaking and gas regulator must be adjusted to system operating pressure.

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Gas regulator(s)	Service report
High voltage probe	Shorting bar
Laser system service manual	VOM
Leak test liquid	

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to gas regulator(s).
8. Shut off main gas supply valve.
   CAUTION: DO NOT PROCEED UNTIL SHUT-OFF VALVE IS CLOSED AND GAS BOTTLE IS SECURE.
9. Remove gas inlet hose.
10. Remove gas outlet hose.
11. Remove gas regulator low pressure electrical switch.
12. Remove regulator from mounting bracket.
13. Install new gas regulator in mounting bracket.
14. Connect inlet gas hose.
15. Purge gas regulator.
16. Connect outlet gas hose.
17. Connect low pressure electrical switch.
18. Remove shorting bar.
19. Connect main power.
20. Energize laser.
    CAUTION: DO NOT TURN ON HIGH VOLTAGE.

DUTY: REPAIRING GAS SUPPLY SYSTEM

PERFORMANCE OBJECTIVE NO. 88

TASK: Replace gas regulator(s) (Continued)

21. Turn on gas supply valve.
22. Test regulator for gas leaks.
    a. Repair gas leaks if necessary.
23. Adjust gas regulator output pressure to laser system specifications.
24. Remove safety glasses.
25. Return laser system to service.
26. Prepare service report.
27. Dispose of defective gas regulator according to facility procedure.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

DUTY: REPAIRING GAS SUPPLY SYSTEM

PERFORMANCE OBJECTIVE NO. 89

TASK: Purge gas regulator(s)

STANDARD: Regulator must be free of any airborne contaminants

CONDITIONS FOR PERFORMANCE OF TASK:

Standard tool kit	Safety glasses
Gas regulator(s)	Service report
High voltage probe	Shorting bar
Laser system service manual	VOM

PERFORMANCE GUIDE:

1. Put on safety glasses.
2. Shut down laser system.
3. Disconnect main power.
4. Insert shorting bar.
5. Attach high voltage probe.
6. Measure voltage remaining in system.
   CAUTION: DO NOT PROCEED UNTIL ALL VOLTAGE HAS BEEN DRAINED FROM SYSTEM.
7. Gain access to gas regulator(s).
8. Shut off main gas supply valve.
   CAUTION: DO NOT PROCEED UNTIL SHUT-OFF VALVE IS CLOSED AND GAS BOTTLE IS SECURE.
9. Remove gas inlet hose.
10. Remove gas outlet hose.
11. Remove regulator from mounting bracket.
12. Remove gas regulator low pressure electrical switch.
13. Install new gas regulator in mounting bracket.
14. Connect inlet gas hose.
15. Review laser system service manual for precautions when working within gas system.
16. Turn pressure adjusting screw control until control feels free of internal spring.
17. Close flow control valve located on output side of regulator.
18. Open cylinder valve and observe pressure on high pressure gauge.
19. Close cylinder valve.
20. Open control valve 1/2 turn.

DUTY: REPAIRING GAS SUPPLY SYSTEM

PERFORMANCE OBJECTIVE NO. 89

TASK: Purge gas regulator(s) (Continued)

21. Turn pressure adjusting screw control until pressure on high pressure gauge returns to zero.
22. Repeat steps #16-21 two more times.
23. Remove shorting bar.
24. Remove safety glasses.
25. Return laser system to service.
26. Prepare service report.

SOURCE FOR STANDARD:

1 Writing Team of Incumbent Workers

APPENDICES

Appendix A

Standard Tool Kit Contents

The components of the standard tool kit referred to in the majority of the performance objectives in this catalog was compiled by the Writing Team. It consists of the following tools, equipment, and work aids.

- Alignment tool
- Assorted screwdrivers
  - Allen
  - Flat blade
  - Phillips
- Assorted wrenches
- Crescent set
  - Combination
  - Open-end
  - Spanner
- Brushes
  - Acid
  - Dusting
- Burnisher
- Clean rags
- Digital cutters
- Electrical tape
- Feeler gauge set
- Files
  - Flat
  - Round
  - Swiss pattern
  - Taper
- Flashlight or penlight
- Forceps
- Hammer
- Hemostat
- Hex key set
- Laser rod O-ring set
- Laser safety goggles
- Mode selector
- Nut driver
- Pliers
  - Diagonal
  - Chain nose
  - Long chain
  - Needle nose
  - Slipjoint
  - Utility
- Pocketknife or utility blade
- Safety glasses
- Scale (6" Eng/meter)
- Socket set
- Solder
- Splice key set
- Tweezers
- Wire cutters
- Wire strippers

A field service laser systems technician may also carry the tools and equipment listed below which may not be readily available to the technician in the field. These have been listed separately in the Performance Objective of each task.

- Cross hair
- Duster
- Energy meter/power meter
- High voltage probe
- High voltage shorting bar
- Lamp extractor tool
- Lamp socket tool
- Mirror holder device
- Mirror retainer removal tool
- Pulse detector
- Soldering iron
- Solder puller
- Teflon tape
- VOM

Appendix B

Tools/Equipment/Work Aids by Percent of Laser Systems Technicians using
(n = 17)

Tools/Equipment/Work Aids	Percent Using
Adjustable wrench	100.0
Allen wrench	100.0
Beamsplitter	100.0
Laser power/energy meter	100.0
Lens mount	100.0
Lens tissue	100.0
Methyl alcohol	100.0
Microscope	100.0
Mirror	100.0
Mirror mount	100.0
Oscilloscope	100.0
Phillips screwdriver set	100.0
Pliers	100.0
Screwdriver	100.0
Tweezers	100.0
Wire cutters	100.0
Ammeter	94.1
Angular adjustment mount	94.1
Focusing lens	94.1
Helium-neon laser	94.1
Lens cleaner	94.1
Mirror holder	94.1
Multimeter	94.1
Ohmmeter	94.1
Tape	94.1
Voltmeter	94.1
Jack stand	88.2
Lens cloth	88.2
Micrometer	88.2
Optical bench	88.2
Polarizer	88.2
Power meter	88.2
Pulse generator	88.2
Scissors	88.2
Spanner wrench	88.2
Water flow meter	88.2
Expander lens	82.4
Hammer	82.4
Mirror retainer remover	82.4
Prism	82.4
Socket assembly set	82.4

Tools/Equipment/Work Aids	Percent Using
Water pressure gauge	82.4
Amplifier	76.5
Compressed air	76.5
Digital energy meter	76.5
Frequency counter	76.5
High voltage capacitator	76.5
IR card	76.5
Safety filter goggles	76.5
Collimator	70.6
Color glass filter	70.6
Function generator	70.6
Fuse kit	70.6
High energy capacitator	70.6
H.V. shorting bar	70.6
Interferometer	70.6
Laser mount	70.6
Neutral density filter	70.6
Optical power meter	70.6
Optical spectrum analyzer	70.6
Photiodiode detector	70.6
Vibration free table	70.6
Water purity meter	70.6
Electro-optic modulator	64.7
Green phosphor screen	64.7
Mode selector	64.7
Optical table	64.7
Spectrum analyzer	64.7
Ultraviolet light	64.7
Acousto-optic modulator	58.8
Autocalameter	58.8
Calorimeter	58.8
Precision laboratory microscope	58.8
Signal generator	58.8
VTVM	58.8
Bird RF meter	52.9
CRT mount	52.9
Dummy load	52.9
Gauge block	52.9
Optical component tester	52.9
Prism table	52.9
Wattmeter	52.9
Digital electronic pulser	47.1
Electrically conducting adhesive	47.1
O-ring seating tool	47.1
RF generator	47.1
Stereo microscope	47.1

Tools/Equipment/Work Aids	Percent Using
Commonpath interferometer	41.2
Glass-to-metal adhesive	41.2
Quartz halogen power supply	41.2
Spectral analyzer	41.2
Wheatstone bridge	41.2
Crystal location tool	35.3
Galvonometer	35.3
Lamp extractor tool	35.3
Lamp socket tool	35.3
Optical encoder	35.3
Rear detector	35.3
Testtape	35.3
Laser safety monitor	29.4
Quartz halogen housing	29.4
Quartz halogen lamp	29.4
Wedge angle measurement device	29.4
Dye laser pump	23.5
LED tester	23.5
Photon drag detector	23.5
Toolmaker's microscope	23.5
Borescope	11.8
Faraday rotator	11.8

These tools, equipment and work aids have been added as a result of further input from the Writing and Review Teams and from the results of write-ins on the occupational inventory.

Air hood
Alignment tool
Combination wrench
Compressed air
Crescent wrench
Cross hair
Digital cutters
Dusting brush
Feeler gauge set
Flashlight
Flat file
Forceps
Hemostat
Hex key set
Nut driver
Open-end wrench
Round file
Safety glasses
Scale (6" Eng/meter)
Solder
Soldering iron
Solder puller
Splice key set
Swiss pattern file
Taper file
Vacuum fore pump
Wire strippers

Appendix C

Bibliography: Sources of Standards

1 Writing Team of Incumbent Workers

Consensus of incumbents in laser technology

. laser technician

. laser systems technician

. laser systems field service technician

APPENDIX D

Cross-Reference Table

This V-TECS catalog is a cumulation of research activities resulting in a description of the following domain area in terms of occupational-related duties, tasks, performance objectives, and performance guides.

Laser Technician
DOT: 019.181-010

Laser Systems Technician
DOT: N/A

The following legend for the cross-reference table codes the results of a task analysis from inventory development, to incumbent survey, to data analysis, to catalog completion.

1.	n	The n accompanying an occupational title is the number of respondents to the occupational survey.
2.	%	Column and row percentage indicates survey responses of performance of a task by incumbents.
3.	#	Indicates a write-in task by incumbents during survey.
4.	Note	Indicates a write-in task to catalog by incumbents during development of catalog. Note indicates no data collected during survey.
5.	(task)	Indicates that consensus of incumbents was used to reword or edit task statement from original task in inventory. Task in parentnesis is the original task.

6.	subscripts	Subscripts are used to indicate subdivision of original task into two or more tasks based upon review and consensus of incumbent workers.
7.	(task, letter number)	Indicates task includes one or more original tasks in original inventory.
	or	
8.	(see task, letter,number)	Task(s) cross-listed into another task(s).
9.	@	An @ indicates accompanying materials are needed and are included in the catalog.
10.	*	Based on analysis of survey data, no performance objective written.

CROSS-REFERENCE TABLE

Laser Systems Technician

Laser Technician
DOT: 019.181-010

Laser Systems Technician
DOT: N/A

Respondents: n = 17

Duties	Tasks	Performance Objective/ Page Numbers	Percent (%) Performing	
			Laser Tech.	Laser Sys. Tech.
A.	MAINTAINING RECORDS			
01	Maintain laboratory notebook	1/1	92.3	75.0
02	Prepare operational log book	2/2	--	--
	(Prepare technical report)		77.0	100.0
03	Prepare shop drawing(s)	3/3	--	--
	(Prepare shop drawing)		84.7	75.0
04	Prepare equipment requisition	4/4	92.3	100.0
05	Prepare service report	5/5	38.4	75.0
06	Prepare expense report	6/6	53.9	75.0
07	Update technical manual	7/7	53.9	75.0
B.	INSTALLING LASER SYSTEMS			
01	Install gaseous laser system	8/8	30.8	50.0
02	Install solid state (YAG) laser system	9/10	61.6	50.0
C.	MAINTAINING LASER SYSTEMS			
01	Inspect reflecting mirrors and focusing optics	10/13	100.0	100.0

Duties	Tasks	Performance Objective/ Page Numbers	Percent (%) Performing	
			Laser Tech.	Laser Sys. Tech.
C.	MAINTAINING LASER SYSTEMS (CONTINUED)			
02	Clean optics	11/14	100.0	100.0
03	Verify Q-switch in YAG laser system	12/16	69.2	50.0
04	Verify polarizer in YAG laser system	13/18	61.6	50.0
05	Test power/energy output at source	14/20	--	--
	(Test power output at source)		92.3	100.0
06	Verify thermal switch operation	15/21	53.9	75.0
07	Test RF power on Q-switch	16/22	69.2	50.0
08	Change water filter	17/23	100.0	100.0
09	Change deionizer cartridge holder	18/24	--	--
	(Change deionizer cartridge)		92.3	100.0
10	Adjust power supply output	19/26	--	--
	(Calibrate power supply output)		53.4	50.0
11	Align complete beam delivery path	20/28	--	--
	(Align complete optics path)		100.0	100.0
	Align cavity optics	21/29	Note	Note
12	Inspect cooler fittings	22/32	100.0	100.0
13	Inspect air circulating filter(s)	23/33	61.6	75.0

Duties Tasks	Performance Objective/ Page Numbers	Percent (%) Performing	
		Laser Tech.	Laser Sys. Tech.
C. MAINTAINING LASER SYSTEMS (CONTINUED)			
14 Clean air circulating filter(s)	24/35	53.9	75.0
15 Replace air circulating filter(s)	25/36	53.9	75.0
16 Measure power/energy output at source	26/37	--	--
(Measure power output at source)		92.3	100.0
17 Verify safety interlock system operation	27/38	92.3	75.0
18 Verify lens focal length	28/39	100.0	100.0
19 Verify repetition rate	29/40	--	--
(Verify rep rate)		84.7	100.0
D. ANALYZING DOWN LASER SYSTEMS			
01 Identify symptoms of problem	30/41	100.0	100.0
02 Troubleshoot temperature control system	31/42	77.0	75.0
03 Troubleshoot beam generation system	32/44	92.3	100.0
04 Troubleshoot excitation system	33/46	92.3	100.0
05 Troubleshoot low voltage power supply	34/48	77.0	50.0
06 Troubleshoot RF system	35/50	61.6	75.0

Duties	Tasks	Performance Objective/ Page Numbers	Percent (%) Performing	
			Laser Tech.	Laser Sys. Tech.
D.	ANALYZING DOWN LASER SYSTEMS (CONTINUED)			
07	Troubleshoot vacuum system	36/52	30.8	50.0
08	Troubleshoot gas supply system	37/54	30.8	50.0
E.	REPAIRING TEMPERATURE CONTROL SYSTEM			
01	Replace cooler fitting(s)	38/56	92.3	100.0
02	Clean cooler fitting(s)	39/58	84.7	100.0
03	Recharge cooling system	40/60	53.9	75.0
04	Replace temperature sensor(s)	41/62	69.2	75.0
05	Replace defective water pump	42/64	92.3	100.0
06	Replace flow sensor	43/66	--	--
	(Replace flow sensor switch)		92.3	100.0
07	Repair defective wiring	44/68	84.7	75.0
08	Replace defective hosing	45/70	84.7	100.0
09	Replace heat exchanger	46/72	69.2	75.0
10	Replace reservoir level switch	47/74	46.1	100.0
11	Replace agitator	48/75	30.8	75.0
12	Replace water solenoid(s)	49/76	53.9	50.0
F.	REPAIRING BEAM GENERATION SYSTEM			
01	Replace crystal rod	50/78	77.0	50.0

Duties / Tasks	Performance Objective/ Page Numbers	Percent (%) Performing	
		Laser Tech.	Laser Sys. Tech.
F. REPAIRING BEAM GENERATION SYSTEM (CONTINUED)			
02 Replace gaseous tube	51/81	30.8	50.0
03 Replace mirror(s)	52/84	100.0	100.0
04 Replace gold cavity	53/85	61.6	50.0
05 Replace electrodes	54/87	84.7	75.0
06 Replace polarizer	55/89	69.2	50.0
07 Replace Q-switch	56/90	77.0	50.0
08 Repair beam expander	57/92	77.0	50.0
09 Replace mirror mount	58/93	100.0	75.0
10 Replace laser housing assembly	59/94	92.3	50.0
11 Replace flash lamp	60/96	77.0	50.0
12 Replace lamp jacket	61/98	77.0	50.0
13 Collimate beam expander	62/100	92.3	75.0
14 Verify peak pulse power	63/102	92.3	100.0
15 Verify frequency of pulse train	64/103	100.0	50.0
G REPAIRING EXCITATION SYSTEM			
01 Replace high voltage capacitors	65/105	53.9	100.0
02 Replace high voltage diodes	66/107	84.7	75.0
03 Replace SCR (silicon control rectifier)	67/109	69.2	75.0

Duties	Tasks	Performance Objective/ Page Numbers	Percent (%) Performing	
			Laser Tech.	Laser Sys. Tech.
G.	REPAIRING EXCITATION SYSTEM (CONTINUED)			
	04 Replace defective board(s)	68/111	84.7	25.0
	05 Repair defective board(s)	69/112	84.7	25.0
	06 Replace high voltage cable(s)	70/113	100.0	75.0
	07 Replace defective resistor(s)	71/115	92.3	75.0
	08 Replace defective fuse(s)	72/117	92.3	75.0
	09 Replace three-phase contactor	73/119	46.1	75.0
	10 Replace high voltage dump contactor	74/121	38.4	50.0
H.	REPAIRING LOW VOLTAGE POWER SUPPLY			
	01 Replace capacitor(s)	75/123	61.6	75.0
	02 Replace diode(s)	76/125	61.6	75.0
	03 Replace low voltage power supply	77/127	61.6	25.0
	04 Replace transformer	78/129	61.6	75.0
I.	REPAIRING RF SYSTEM			
	01 Replace RF cable connector(s)	79/131	53.9	75.0
	02 Replace RF driver	80/133	53.9	75.0
J.	REPAIRING VACUUM SYSTEM			
	01 Replace vacuum pump	81/135	30.8	50.0
	02 Replace vacuum hose(s)	82/137	30.8	50.0

Duties / Tasks	Performance Objective/ Page Numbers	Percent (%) Performing	
		Laser Tech.	Laser Sys. Tech.
J. REPAIRING VACUUM SYSTEM (CONTINUED)			
03 Purge vacuum system	83/139	30.8	50.0
Change vacuum pump oil	84/140	Note	Note
K. REPAIRING GAS SUPPLY SYSTEM			
01 Replace gas flow gauge(s)	85/142	30.8	50.0
02 Replace gas solenoid(s)	86/144	30.8	50.0
03 Repair gas leak(s)	87/146	23.0	50.0
04 Replace gas regulator(s)	88/148	23.0	50.0
Purge gas regulator	89/150	Note	Note

Appendix E

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